Automatic Weather Station
MAWS201

USER'S GUIDE

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VAISALA

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Table of Contents

CHAPTER 1

GENERAL INFORMATION

This chapter provides general notes for the product and this manual.

About This Manual

This manual provides information for Vaisala HydroMet™ Automatic Weather Station MAWS201 equipped with meteorological and/or hydrological sensors.

Contents of This Manual

This manual consists of the following chapters:

- Chapter 1, General Information: This chapter provides general notes for the product and this manual.
- Chapter 2, Product Overview: This chapter introduces the features, accessories, sensors, and the product nomenclature.
- Chapter 3, Selecting Location: This chapter provides information on siting the station and the sensors correctly.
- Chapter 4, Installation: This chapter describes how to install MAWS and the accessories and sensors connected to it.
- Chapter 5, Operation: This chapter provides the instructions for taking MAWS into use when all the equipment has been assembled and installed, as well as operating instructions for the MAWS Terminal software.

- Chapter 6, Maintenance: This chapter provides information that is needed in the basic maintenance of MAWS, sensors, and accessories.
- Chapter 7, Troubleshooting: This section consists of some common MAWS problems, their probable causes, and remedies.
- Chapter 8, Technical Data: This chapter provides the technical data of MAWS and its sensors.
- Appendix A, Glossary: This appendix contains glossary with explanations of some general meteorological and technical terms and terms used in specifications.

General Safety Considerations

Throughout the manual, important safety considerations are highlighted as follows:

WARNING	Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death.

CAUTION	Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost.

NOTE	Note highlights important information on using the product.

Feedback

Vaisala Customer Documentation Team welcomes your comments and suggestions on the quality and usefulness of this publication. If you find errors or have other suggestions for improvement, please indicate the chapter, section, and page number. You can send comments to us by e-mail: manuals@vaisala.com.

Product Related Safety Precautions

MAWS has been tested for safety and approved as shipped from the factory. The following safety precautions are not related to any specific procedures and therefore do not appear elsewhere in this manual. They are recommended precautions that personnel must understand and apply during different phases of operation and maintenance.

WARNING Keep away from live circuits. Operating personnel must observe safety regulations at all times. Component replacement or internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltages may exist for some time even with the power cable disconnected. To avoid injuries, disconnect power and discharge circuits before touching them.

WARNING Do not service alone. Under no circumstances should any person reach into parts and assemblies that are mains powered and alive, for the purpose of servicing, except in the presence of someone who is capable of rendering aid.

WARNING Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

WARNING Do not service a live system outdoors. Do not open units outdoors when the enclosure contains line voltage levels.

WARNING Do not operate in an explosive atmosphere, for example, when flammable gases or fumes are present. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

WARNING Do not substitute parts or modify the instrument. Because of the danger of introducing additional hazards, do not install unsuitable parts in the instrument. Contact Vaisala or its authorized representative for repairs to ensure that safety features are maintained.

WARNING	Be careful when erecting the mast. See that there are no power lines or other obstacles above the mast.

WARNING	Secure the mast properly to prevent it from falling. Tighten all the adjustment screws securely.

CAUTION	Do not make changes to the wiring. Incorrect wiring can damage the device and prevent it from operating correctly.

CAUTION	Be careful when moving the mast. To prevent damage to the sensors, remove them (and the sensor arms) before moving the station.

NOTE	When disposing of old batteries, be sure to do so in accordance with all regulations applicable in your area.

ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching, removing, or inserting any objects inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

- Handle ESD sensitive components on a properly grounded and protected ESD workbench. When this is not possible, ground yourself with a wrist strap and a resistive connection cord to the equipment chassis before touching the boards. When neither of the above is possible, at least touch a conductive part of the equipment chassis with your other hand before touching the boards.
- Always hold the boards by the edges and avoid touching the component contacts.

Recycling

Recycle all applicable material.

Dispose of batteries and the unit according to statutory regulations. Do not dispose of with regular household refuse.

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Warranty

For certain products Vaisala normally gives a limited one-year warranty. Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or Conditions of Sale for details of the warranty for each product.

CHAPTER 2

PRODUCT OVERVIEW

This chapter introduces the features, accessories, sensors, and the product nomenclature.

Vaisala HydroMet™ Systems include compact stations that can be used either with a portable tripod or with pole masts of different heights in fixed installations. The station comes with a set of sensors that measure certain meteorological and/or hydrological quantities and that have been especially selected for use with Vaisala HydroMet™ Systems.

Vaisala HydroMet™ Automatic Weather Station MAWS201

Vaisala HydroMet™ Automatic Weather Station MAWS201, a portable (mobile) AWS for temporary installations, features a lightweight aluminum tripod and easy-to-use connectors that make it fast to set up. Each leg is adjustable for use on uneven terrain. With 5 basic sensors, a solar panel, and an internal battery, MAWS201 weighs only approximately 15 kg.

When you have purchased a portable MAWS201 with a basic sensor set, your station typically consists of the components presented in Figure 1 on page 16.

When your portable MAWS201 includes Vaisala Weather Transmitter WXT510, your station typically consists of the components presented in Figure 2 on page 17.

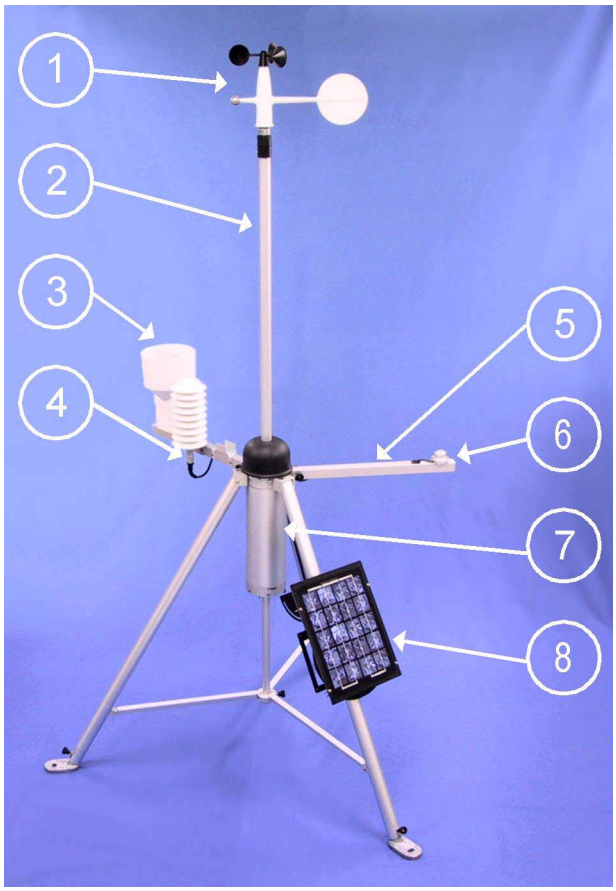


Figure 1 Components of the MAWS201 Station

The following numbers refer to Figure 1 on page 16:

1 = Wind Sensor

2 = Wind Mast

3 = Rain Gauge

4 = Air Temperature and Relative Humidity Sensor with radiation shield

5 = Sensor Arm

6 = Solar Radiation Sensor

7 = Tube that includes the logger, rechargeable internal battery, and optionally Pressure Sensor

8 = Solar panel for generating current for recharging the internal battery

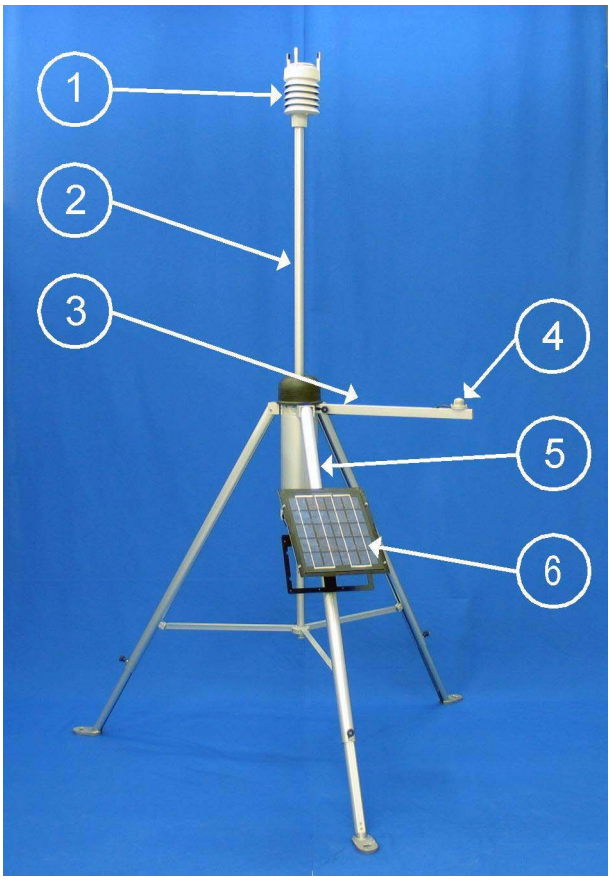


Figure 2 Components of the MAWS201 Station with Weather Transmitter

The following numbers refer to Figure 2 on page 17:

1 = Weather Transmitter

2 = Wind Mast

3 = Sensor Arm

4 = Solar Radiation Sensor

5 = Tube that includes the logger, rechargeable internal battery, and optionally Pressure Sensor

6 = Solar panel for generating current for recharging the internal battery

In addition to the numbered items, the delivery contains a portable mast assembly consisting of a tripod with adjustable extension legs attached to the logger housing. The tripod can easily be collapsed to fit in a transit case.

NOTE	The appearance of the solar panel in your MAWS may differ from the one in the figures.

Product Nomenclature

The following tables provide the equipment nomenclature.

Table 1 MAWS201 Basic Set

Code	Common Name
	Tools, ground pegs, and sand bag
MAWS Lizard	Setup software
MAWS Terminal	MAWS Terminal software
MAWS YourVIEW	Graphical Display Software (Basic version)
QMA101	Sensor arm
QMB101	Battery (internal rechargeable)
QML201	AWS Logger
Tripod	3 m (10 ft.) portable mast with the enclosure, accessories, and a sensor support arm for MAWS201

Table 2 Optional Accessories

Code	Common Name
QMB102	Additional Internal Battery
QMD170	Handheld Display
QMM110	Carry case set (canvas bag for tripod, hard case for sensors)
QMM120	Carry case set (hard case for tripod, hard case for sensors
QMP201C	Solar/Mains power supply
QMP213	Mains power supply
SOLAR6	6 W solar panel

Table 3 Communication Options

Code	Common Name
DMX501	Modem module (fixed line)
DSI485A	RS-485 module (isolated)
DSI486	RS-485/RS-232/SDI-12 module (dual-isolated)
DSU232	RS-232 module (dual)
SATEL3ASET-M2	Radio modem SATELLINE 3AS with accessories

Table 4 Sensor Options

Code	Common Name
DTR502	Radiation shield for HMP45D
ECH2O-M3	Soil moisture sensor
HMP45D	Air temperature and relative humidity sensor (referred to as QMH101 when connected to MAWS)
ML2x	Soil moisture sensor
PMT16A	Pressure sensor
PR36W	Water level sensor
QFM101	Fuel moisture sensor
QLW101	Leaf wetness sensor
QMH101	See HMP45D
QMN101	Net solar radiation sensor
QMR101	Rain gauge (on sensor arm)
QMR102	Rain gauge (stand-alone)
QMS101	Global solar radiation sensor (photo diode)
QMS102	Global solar radiation sensor (thermopile)
QMT103	Soil/water temperature sensor
QMT107	Soil temperature sensor
QMT110	Soil/water temperature sensor with 10-meter cable
QMW101	See WMS302 (equipped with MAWS compatible 1 m cable)
QMW110	See WMS302 (equipped with MAWS compatible 10 m cable)
WMS302	Combined wind direction and speed sensor (referred to as QMW101 or QMW110 depending on the cable length)
WXT510	Weather transmitter

AWS Logger

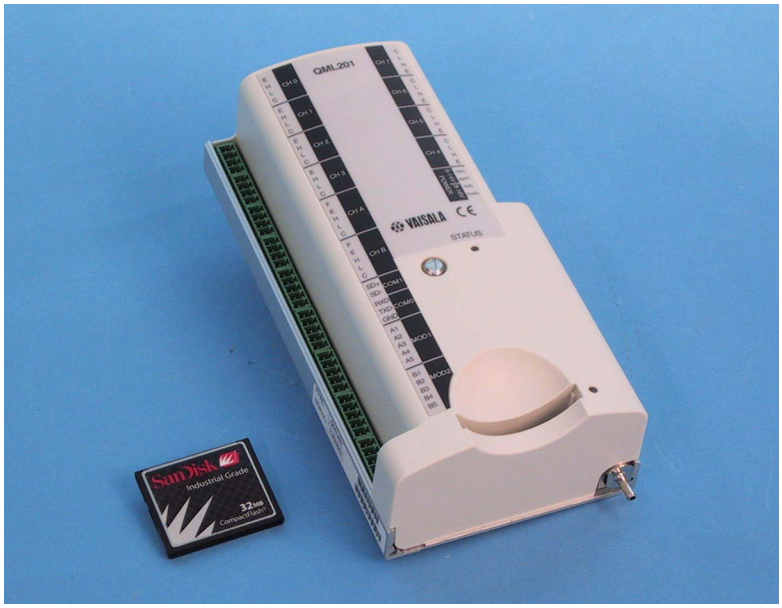


Figure 3 AWS Logger QML201

QML201 is a complete AWS logger designed on one printed board only. This board contains a 32-bit Motorola CPU for data processing and 10 differential (20 single ended) analog sensor inputs (these can also be used as digital inputs). Moreover, there are two frequency sensor interfaces, a 16 bit A/D converter, 1.6 Mb of secure Flash memory for data logging, as well as excitation power supply for sensors and charger for the internal backup battery.

The board uses the latest SMD (Surface Mount Device) technology and is conformal coated for improved protection also in high humidity. Each sensor input has a varistor (VDR) protection against induced transients. The serial line connections, that is, RS-232 labeled as COM0 and RS-485 labeled as COM1, have two level ESD protection circuits with VDRs directly at input pins.

The logger is located in the tube and is further encased to protect the circuit board and the battery.

The cover of the logger can be removed for installing the battery and for resetting MAWS. In Figure 4 on page 21, the logger is shown without the cover and the optional communication modules.

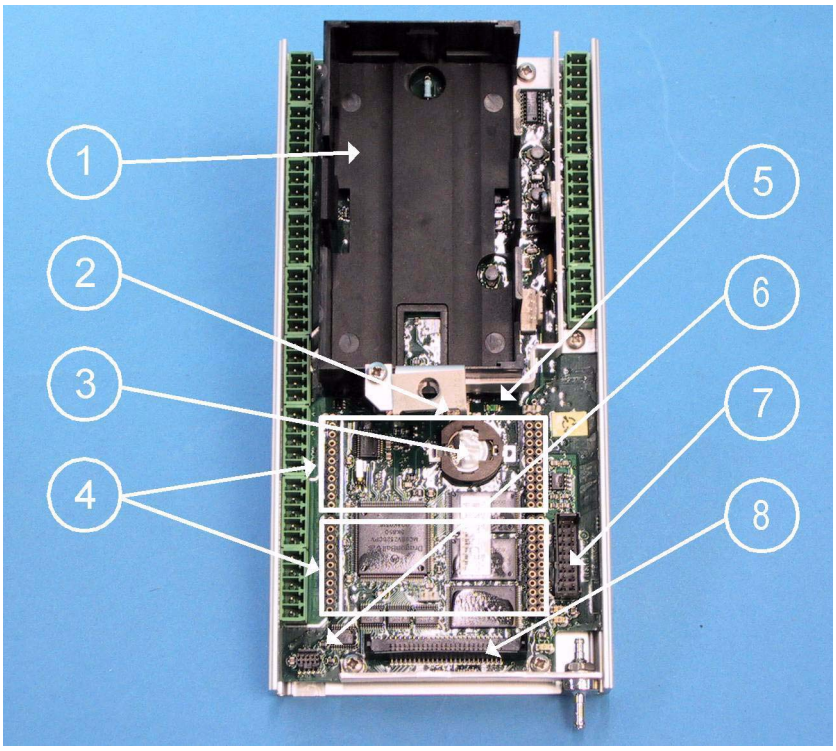


Figure 4 AWS Logger QML201 without Cover

The following numbers refer to Figure 4 on page 21:

1 = Place for the internal battery
2 = Reset button (under the bracket)
3 = Lithium battery for RTC
4 = Communication module places MOD1 and MOD2
5 = Status LED
6 = SPI connector
7 = Pressure sensor connector
8 = CF Card connector

The logger is equipped with CF card slot for logging a large amount of data. The data is logged into daily files making it easy to locate any particular data set for further analysis. Currently there are cards available from 32 MB up to hundreds of MBs. These cards can be read directly in the PC. Several different types of readers are commercially available: internal PCMCIA reader as well as external readers to be connected to USB or parallel port of a PC. Vaisala recommends the

usage of industrial grade CF cards from Sandisk, which have been tested to function in harsh environments.

Figure 5 Compact Flash Memory Card Readers

Optional modules include, for example, various communication modules, and built-in pressure transducer.

MAWS is a low-power system. The logger consumes less than 10 mA from a 6 V battery (5 mA from a 12 V battery). MAWS can be powered using a solar panel or optionally using a 110/230 AC power supply. External DC supply (8 to 14 VDC recommended, 30 VDC max) can also be used as the main power source for MAWS.

The power consumption of the complete MAWS system depends on the connected sensors, communication devices, and other options included in the delivery. For example, MAWS with the basic set of 5 sensors, each having 10-minute measuring interval, has an average power consumption of 10 mA / 6 VDC (5 mA / 12 VDC).

Internal Battery

Normally, the internal battery QMB101 is used as the primary power supply. The battery is recharged by the integral charger in the logger, accepting input from a solar panel, mains adapter, or an outdoors mains power supply. The internal battery QMB101 is placed on top of the circuit board, under the logger cover.

Backup capacity with average power consumption of 10 mA (basic set of 5 sensors, 10 min measuring interval) is 130 hours. The battery can be charged with the logger.

NOTE	When a 12 V backup battery is used, it is recommended that QMB101 is disconnected by removing the red battery connector from the CPU. This way the current consumption will be reduced when the charging circuits of QMB101 are not in use.

Additional Internal Battery

The additional internal battery QMB102 is easily installed to the existing DIN-rail inside the tubular enclosure. The in-built battery charger on the MAWS logger will charge the additional battery as well.

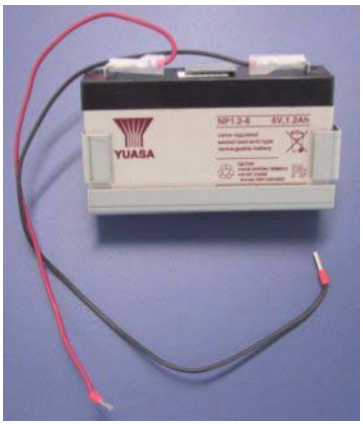


Figure 6 Additional Internal Battery QMB102

Wall Adapter

A usual wall adapter (110/230 VAC, output min. 12 V/500 mA) can be used when the distance to the MAWS system is less than 100 m (328 ft.), provided that the wall adapter can be installed indoors.

NOTE	When the power cable resistance exceeds 10 Ω, a capacitor (from 100 to 200 µF, 40 V) should be added between GND and +ExtDC pins. Make sure that the polarity is correct.

MAWS Software

Operating Software

The embedded operating software runs in the AWS logger. Access to the operating software commands can be gained using the MAWS Terminal.

MAWS Terminal

MAWS Terminal is the terminal software for working with the MAWS stations. MAWS stations measure sensor data and store it in log files. With the MAWS Terminal software, you can download these files to your PC and view them.

When you start using MAWS, the first thing you need to do is to define what parameters you want to measure and at what frequency. You can do this by uploading a configuration file from your PC to the MAWS system.

MAWS Terminal is also used for setting station-specific parameters such as the station name, altitude, pressure sensor height, and sensor-specific calibration coefficients. In addition, the date and time can be set with the easy-to-use MAWS **Station Settings** template.

After you have uploaded the setup files to MAWS, you can browse the MAWS data files by downloading them from MAWS to your PC. You can browse them in MAWS Terminal or in other applications. You can define several download settings such as where you want to save the downloaded files and what operations the program performs automatically at each download.

MAWS Lizard Setup Software

MAWS Lizard Setup Software is used to modify the software parameters and operation of the MAWS systems. With the MAWS Lizard software you can create or modify a setup file that informs MAWS how to operate.

Creating a setup with MAWS Lizard Setup Software consists of three stages. First, you define an assembly for the MAWS system. Then you

define the necessary measurements and the calculations derived from them. Finally, you define reports and log groups from the measurement results.

The setup file on your PC is finally generated, in other words, converted into a format that MAWS understands, and then transferred into MAWS and taken into use.

Accessories

Sensor Arm

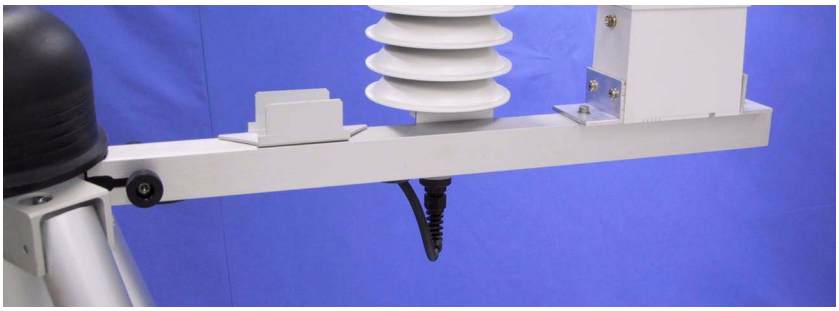


Figure 7 Sensor Arm QMA101

Certain sensors can be installed on the QMA101 sensor arm. The arm includes factory made drillings for every sensor model to be installed.

Carry Case Sets

The carry cases for MAWS201 are made of cellular polypropylene (EPP). This lightweight but very rugged material provides excellent cushioning during transport. The cases are equipped with handles, hinges, and latches for which padlocks can be used. The larger case for the tripod is also equipped with a pair of wheels. There are two sets of carry cases to choose from.

QMM110

Figure 8 QMM110 Carry Case Set

The Basic Set QMM110 consists of one hard case for the sensors and accessories, and one soft canvas case for the tripod, solar panel, wind mast, as well as hammer and ground pegs.

QMM120

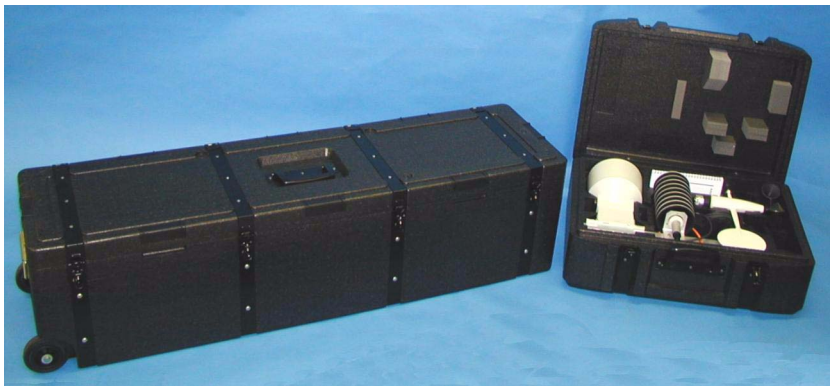


Figure 9 QMM120 Carry Case Set

The Extended Set QMM120 consists of two hard cases, one for the sensors and accessories, and the other for the tripod, solar panel, wind mast, as well as hammer and ground pegs. The smaller case weighs only 3.6 kg (7.9 lb.) and the larger 9.2 kg (20.3 lb.).

Mains Power Supply

Figure 10 Mains Power Supply QMP213

QMP213 is an outdoors power supply for installations where the AC power is available. It has a weatherproof enclosure made of durable, UV-resistant poly carbonate reinforced with glass fiber. The enclosure's environmental specification is IP66.

QMP213 is equipped with protection circuits for transient overvoltage both at the input and the output, as well as replaceable fuses at the both input lines, hence enabling also mobile use. The output is fully protected against short-circuits. LED provides indication of mains voltage presence. The input may vary from 90 to 264 VAC with a frequency of 50 or 60 Hz. The power consumption is 1 A. The output provides 12 VDC, 2.5 A.

Solar/Mains Power Supply

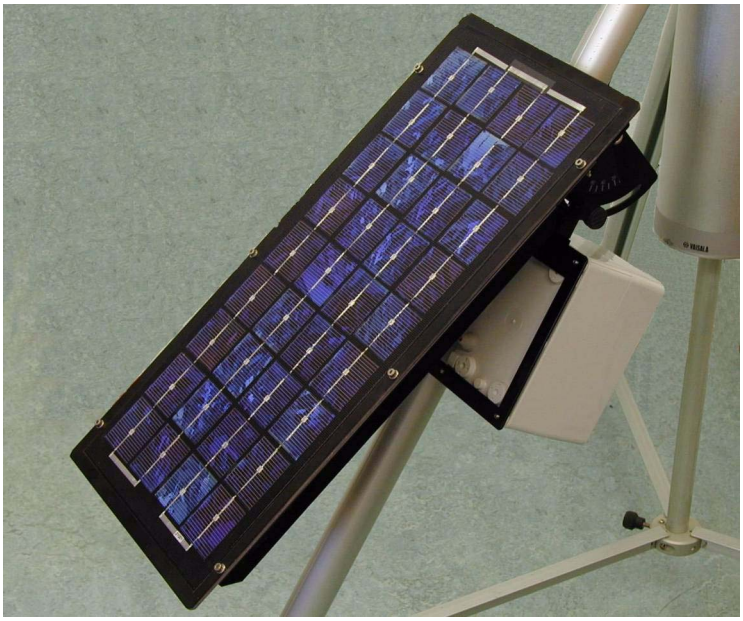


Figure 11 Solar/Mains Power Supply QMP201C

QMP201C is a power supply for installations where a lot of power and back-up capacity are needed. Additionally, QMPC201C can provide 12 V supply voltage required, for example, for the optional radio modem set. QMP201C includes the following internal modules: 12 W solar panel, battery regulator, mains power supply, and 7 Ah back-up battery. The unit is easily mounted to the tripod's leg.

Battery Regulator

Battery Regulator QBR101B is a charging and supervising equipment for 12 and 24 V lead acid and nickel-cadmium batteries. QBR101B allows simultaneous input from solar panel and AC power.

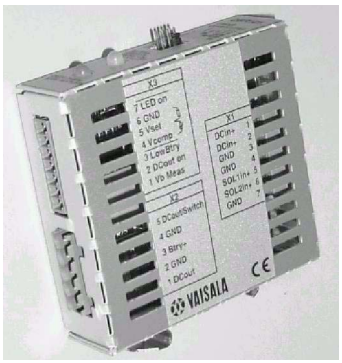


Figure 12 Battery Regulator QBR101B

The maximum charging current can be set by the internal jumper settings from 0.5 to 2.5 A being applicable for battery capacity of 4 to 72 Ah. The self-consumption from the battery is very low, less than 0.2 mA.

The LED lamps are also included, they indicate the conditions. In order to maximize autonomy time, the lamps are activated only while the ON button is bushed.

Mains Power Supply

The AC power supply unit BWT15SXZ is a switching power supply, which operates from the universal AC input of 85 to 264 VAC and 47 to 440 Hz. The output voltage is 15 VDC, which is used for powering the system connected to it, and as an input to the QBR101B battery regulator for charging the backup battery.

AC Power Cable

If AC power (230 or 115 VAC) is available on the installation site, and/ or solar power is not feasible, an AC power cable can be used to charge the batteries instead of the solar panel, or the batteries can be charged in advance at the base.

Solar Panel

SOLAR6

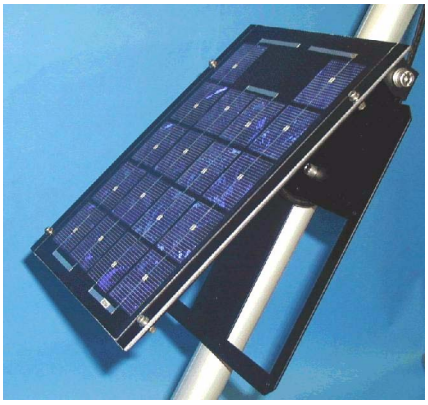


Figure 13 Solar Panel SOLAR6

SOLAR6 is a 6 W solar panel, see Figure 13 on page 30. The angle of the panel is adjustable.

The SOLAR6 solar panel contains 18 high efficiency polycrystalline silicon cells in series optimized for the specific voltage demand. The solar panel's cells are protected from dirt, moisture and impact by a tough fluoropolymer front film. The solar circuit is laminated using EVA between this film and adurable glass fibre board back which includes integral mounting holes.

The cells are protected from dirt, moisture and mechanical impact using a tempered, low iron glass front. The solar circuit is laminated using EVA between tempered glass and a durable, multi-layered polymer back sheet for superior moisture resistance.

RS-232 Module

The RS-232 Communication Module DSU232 is an unisolated RS-232 module that will provide either a double serial channel without handshaking or a single RS-232 with handshaking. It has an ability to feed 12 V (45 mA) for the serial sensors. The power consumption is less than 15 mA when communicating, less than 5 mA at standby.

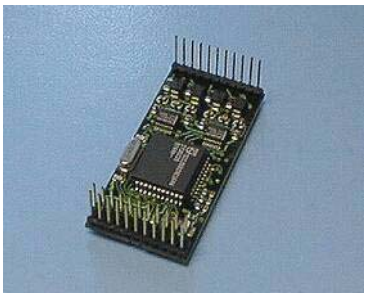


Figure 14 Communication Module DSU232

RS-485 Modules

Introduction to DSI485A

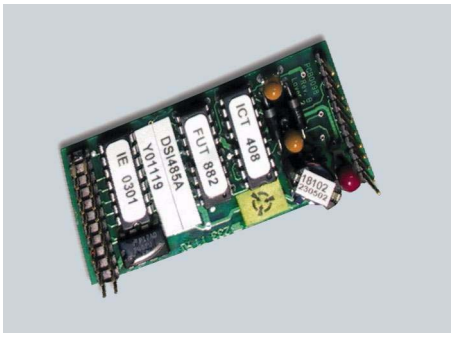


Figure 15 Isolated Communication Module DSI485A

DSI485A is an isolated communication module for providing the 2-wire or 4-wire RS-485-communication link between two devices with a similar interface. The DSI485A module is used, for example, for connecting displays and terminals to the data logger when the distance is longer than 15 meters. The maximum distance for DSI485A is approximately 1500 meters at full speed. The DSI485A module must be configured before using it in order to work as desired.

Introduction to DSI486

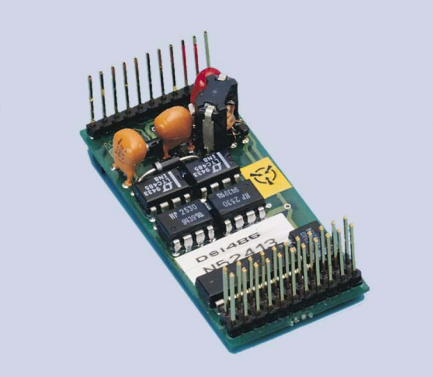


Figure 16 Dual-Isolated Communication Module DSI486

DSI486 is a dual-isolated communication module, which can be used in the RS-232, RS-485, or SDI-12 mode. The communication mode is selected by the correct wiring of the I/O pins and with the correct jumper settings on the board. The DSI486 module is used, for example, for connecting displays, terminals, and the data logger together when the distance is longer than 15 meters. The maximum distance for DSI486 is approximately 1500 meters at full speed. The DSI486 module must be configured before using it in order to work as desired.

The RS-485/422 channels A and B are galvanically isolated from the host board's electronics. The +5 VDC power supplies of channels A and B are also isolated from each other with capacitors. Thus, it is possible to wire these two channels to separate locations.

The RS-232 mode utilizes channel B. When channel B is used in the RS-232 mode, it is possible to use channel A as a galvanically isolated two-wire RS-485 channel. The RS-232 channel is galvanically connected to the host board's GND potential.

The SDI-12 channel has its own connecting point on the board. It does not use channel A or B for the communication. SDI-12 is galvanically connected to the host board's GND potential.

Modem Module

The DMX501 modem module is used for providing long distance fixed line connection between two Vaisala devices with a similar interface. It is used when the distance is up to 10 km, for example, between MAWS and Digital Display, or between Ceilometer CT25K and MAWS. Through this I/O port, a remote location can send reports and data or the host can poll them. The DMX501 modem module must be configured before using it so that it works as desired.

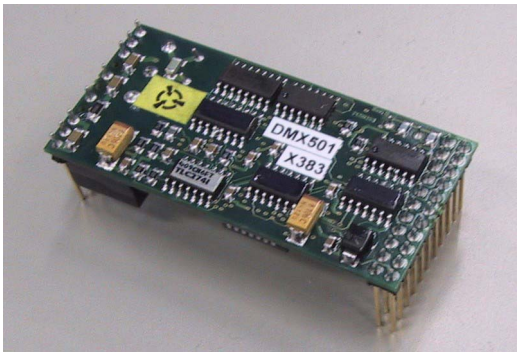


Figure 17 Modem Module DMX501

The DMX501 modem module supports the following communication standards:

- V.21, 300 bps FSK
- V.23, 1200 / 75 bps FSK
- V.22, 1200 bps DPSK

UHF Radio Modem

Figure 18 UHF Radio Modem SATELLINE 3AS

The SATELLINE 3AS UHF radio modem is a half-duplex radio modem suitable for high-speed data applications. This radio modem offers high speed data transmission up to 40 km Line-Of-Sight (LOS). As a UHF radio modem, it provides the data speeds 19200 bps at 25 kHz and 9600 bps at 12.5 kHz in the air. RS interface data speed is user selectable from 300 to 38400 bps. The connection between data logger and the radio modem is established by using RS-232.

Repeater Function

Message Routing is a built-in feature in the SATELLINE-3AS modems, which makes it easier to build up a large radio modem network. Message Routing features a versatile radio protocol, which takes care of routing messages across a radio modem network. Only one radio channel is required even in large networks. Any radio modem in the network can act as a repeater and have a weather station interfaced as well. The repeater can also be chained allowing message transmission through several repeaters/weather stations.

Using the in-built functions in the Satelline 3AS radio modems, two different types of repeater operations can be built:

1. The weather station having the radio modem will function as a repeater for a group of other stations
2. The radio modem alone installed in an enclosure with proper powering can function as independent repeater for a group of weather stations.

Weather Transmitter

Figure 19 Weather Transmitter WXT510

Weather Transmitter WXT510 is a small and lightweight transmitter that offers six weather parameters in one compact package. WXT510 measures wind speed and direction, precipitation, atmospheric pressure, temperature and relative humidity.

WXT510 powers up with 5...30 VDC and outputs serial data with a selectable communication protocol: SDI-12, ASCII automatic & polled and NMEA 0183 with query option. Four alternative serial interfaces are selectable: RS-232, RS-485, RS-422 and SDI-12.

Combined Wind Sensor

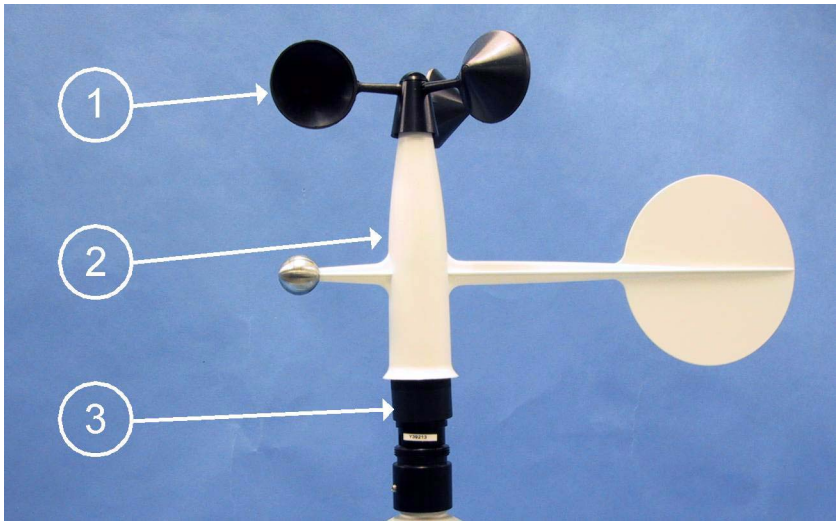


Figure 20 Combined Wind Sensor

The following numbers refer to Figure 20 on page 36:

1 = Cup wheel assembly

2 = Vane assembly

3 = Sensor compartment

Combined Wind Sensor is the compact sized instrument with the wind speed and direction sensors integrated into one unit. A single compact sensor is ideal for low-power applications. The sensor electronics is located inside a watertight compartment providing full protection against water, dust, pollutants, and electromagnetic interference.

The cup wheel shape, dimensions, and material have been carefully designed to achieve maximum measurement quality. The conical cups have been tested to give linear response between wind speed and angular velocity of the cup wheel. The polyamide plastic reinforced with carbon fiber guarantees a rigid structure even at the highest wind speeds.

The balanced wind vane is integrated in the housing, underneath the cup wheel. The circular tail is located far enough from the body and the cup wheel to avoid turbulence due to these structures. The vane assembly is made of PA reinforced with glass fiber providing durable and lightweight structure with fast response and low inertia.

WMS302 has a two-wiper type potentiometer to overcome the wind direction discontinuity. However, a more complex voltage-to-direction conversion process is needed.

Air Temperature and Relative Humidity Sensor

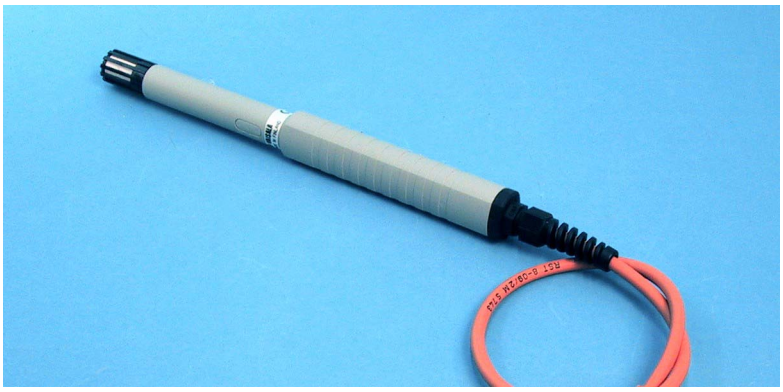


Figure 21 Air Temperature and Relative Humidity Sensor

The Air Temperature and Relative Humidity Sensor is based on Vaisala's field-proven HMP45D probe and comes with a special cable and connector. Humidity measurement is based on the highly accurate capacitive thin film polymer sensor HUMICAP®180 and it offers excellent long-term stability in a wide range of environments. Temperature measurement is based on resistive platinum Pt-100 IEC751, 1/3 Class B sensor. Both the humidity and temperature probes are located at the tip of the sensor and are protected by a membrane filter.

Pressure Sensor

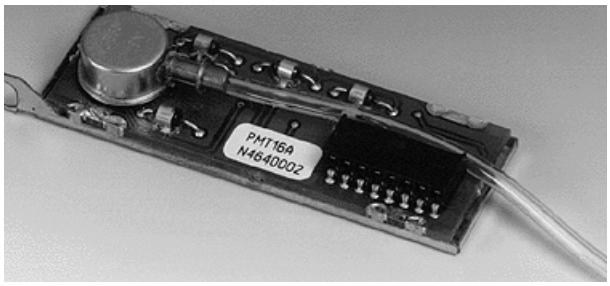


Figure 22 Pressure Sensor PMT16A

The silicon capacitive pressure sensor PMT16A has excellent accuracy, repeatability and long-term stability over a wide range of operating temperatures. Therefore, it maintains its accuracy and calibration for long periods of time, thus reducing the need for field calibrations.

The fine adjustment and calibration of the sensor at the factory are handled according to the electronic working standards, which are based on international standards.

Rain Gauges

Figure 23 Rain Gauge QMR101

Rain gauge QMR101 is economical and accurate rain gauge of plastic material which is highly resistant to UV-radiation and even frost proof. QMR101 has a self-emptying tipping spoon of 0.2 mm (0.008 in.) capacity. Due to its small size, lightweight, and rugged design, it is especially suitable for portable applications and temporary installations. QMR101 is installed on the sensor arm, and has a ready-made cable with the connector.

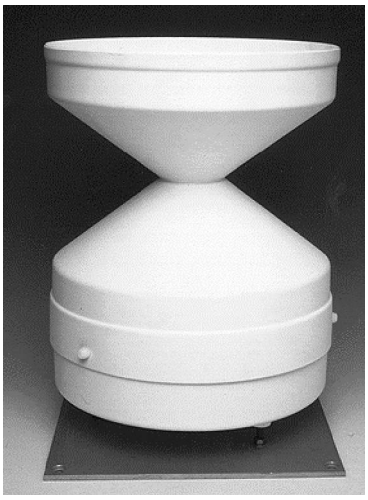


Figure 24 Rain Gauge QMR102

An aerodynamically shaped rain gauge, Precipitation Sensor QMR102 is designed to minimize the wind-originated airflow reducing the catch. Manufactured from UV radiation resistant plastic, that makes it a very rugged instrument.

The collected rain is measured in a well-proven tipping bucket mechanism of 0.2 millimeters. QMR102 is installed on a stand or on a pedestal and it is delivered with a 10-meter shielded cable with a connector.

Pyranometers

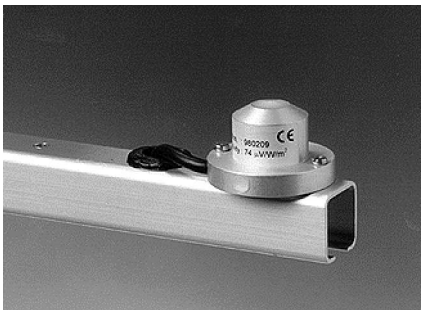


Figure 25 QMS101 Pyranometer

The QMS101 pyranometer is used for measuring global solar radiation. QMS101 uses a photodiode detector for creating a voltage output proportional to the incoming radiation. Due to the unique design of the

diffuser, its sensitivity is proportional to the cosine of the angle of incidence of the radiation, thus allowing accurate and consistent measurements. QMS101 has a ready-made cable with a connector, and it is easily installed on the sensor support arm.

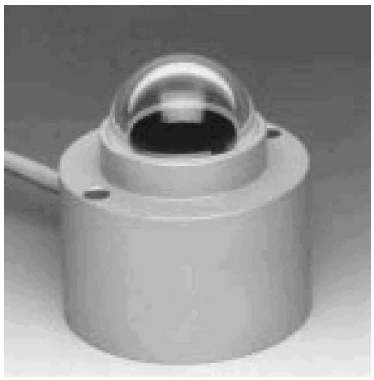


Figure 26 QMS102 Pyranometer

QMS102 Pyranometer is an ISO/WMO-classified second class pyranometer. The precision optical glass dome acts as a filter, with a spectral band-pass that permits the full solar spectrum to pass through to the sensor. The sensor is a high-quality blackened thermopile with a flat spectral response. Heating of the sensor by incoming solar radiation produces a signal in the microvolt range.

Net Solar Radiation Sensor

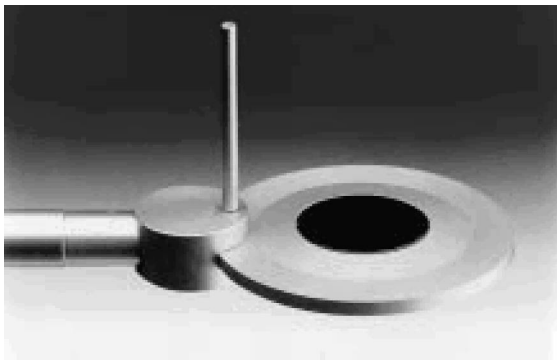


Figure 27 Net Solar Radiation Sensor QMN101

Net Solar Radiation Sensor QMN101 is designed for routine measurements of net radiation. Net radiation is the balance between

incoming and outgoing radiation in outdoor conditions. The sensor measures solar and far infra-red radiation balance.

The sensor is based on a thermopile and it consists of two Teflon-coated, weather-resistant black conical absorbers. The voltage output is proportional to the net radiation. Contrary to common instruments, QMN101 is virtually maintenance-free as it does not require fragile plastic domes.

Soil/Water Temperature Sensors

Figure 28 Soil/Water Temperature Sensor

Soil/Water Temperature Sensor is particularly intended for precision measurement of ground and soil temperatures. All the materials have been carefully selected to withstand various environmental stress and wide temperature range. The measurement accuracy and stability of the temperature sensor are based on a Pt-100 type sensor element specified to 1/4 DIN 43760B preciseness level.

The QMT103 sensor includes a 5-meter cable with a black, weather-resistant polyurethane (PUR) sheath, which can tolerate both abrasive wear and extreme temperatures. Molded to the other end of the cable there is a 5-pin watertight connector, providing for instant assembly and replacement.

The QMT110 sensor includes a 10-meter cable with a black, weather-resistant polyurethane (PUR) sheath, which can tolerate both abrasive wear and extreme temperatures. Molded to the other end of the cable there is a 5-pin watertight connector, providing for instant assembly and replacement.

Soil Temperature Sensor

Figure 29 Soil Temperature Sensor QMT107

Soil Temperature Sensor QMT107 is designed for the measurement of soil temperature and temperature profiles as a function of depth. Temperature measurement is based on resistive platinum sensors (Pt-100). There are seven temperature probes located inside the sensor. The sensors are positioned to +5 cm, ±0 cm, -5 cm, -10 cm, -20 cm, -50 cm, and -100 cm levels, where ±0 cm corresponds to the ground level mark of the sensor.

The sensor is constructed of glass fiber tube filled with epoxy, which makes the design watertight and provides low thermal conductivity. This ensures maximum accuracy as the sensor itself consumes very little power, thus causing almost no self-heating. The sensor has a 1-meter cable, which can be extended with the extension cables of different lengths.

Soil Moisture Sensor

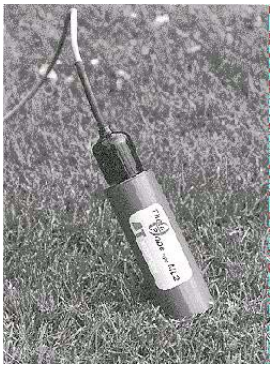


Figure 30 Soil Moisture Sensor ML2x

Soil Moisture Sensor ML2x features a new technique with the accuracy of ±2 % soil moisture. The ML2x sensors offer high accuracy and extended lifetime in permanent or temporary measurements of soil moisture.

Traditional low cost sensors made of gypsum block dissolve even in a short period of time when exposed to high moisture. The ML2x sensors are very durable. The rods are 60 mm long, made of resilient, solid stainless steel, and can be unscrewed and replaced if necessary. All exposed materials are either stainless steel or durable plastic, and the probes are fully sealed. This way they can also safely be buried into the ground.

Soil Moisture Sensor

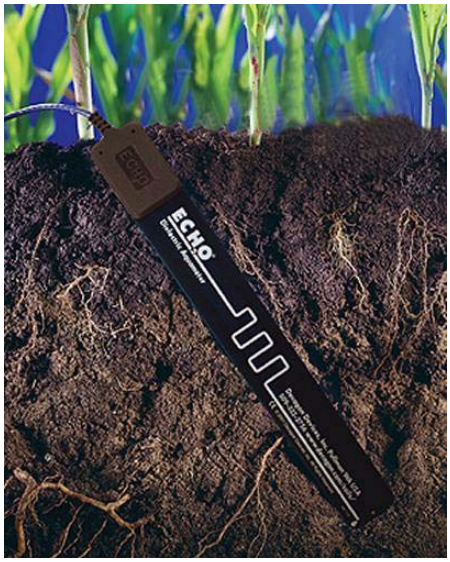


Figure 31 Soil Moisture Sensor ECH2O-M3

The ECH2O-M3 probe is a low-cost sensor for measuring volumetric water content of soil and other porous materials. It uses capacitance to measure the dielectric permittivity of the surrounding medium. The volume of water in the total volume of soil most heavily influences the dielectric permittivity of the soil because the dielectric of water (80) is much greater than the other constituents of the soil (mineral soil, 4; organic matter, 4; air, 1). Thus, when the amount of water changes in the soil, the ECH2O-M3 probe will measure a change in capacitance (from the change in dielectric permittivity) that can be directly correlated with a change in water content. Circuitry inside the ECH2O-M3 probe changes the capacitance measurement into a proportional millivolt output. The ECH20-M3 probe has a low sensitivity to salt and temperature, and very low power consumption.

Submersible Water Level Sensor

Figure 32 Submersible Water Level Sensor PR-36W

Submersible Water Level Sensor PR-36W determines the water level by measuring the water pressure above the submerged sensor in reservoirs, lakes and rivers. The PR-36W pressure sensor is a high stability piezoresistive device designed for use in transmitters, where accuracy and stability are essential. The sensor is selected after severe testing under pressure and temperature. The sensing component is a micro-machined silicon chip of high sensitivity mounted in a floating arrangement. An independent temperature sensor is integrated on the surface of the silicon chip. The pressure signal compensation uses a mathematical model based on polynomial approximation, which provides almost perfect compensation over the operating temperature range.

The user can, via RS-485 interface and using a special adapter cable, set the zero and gain of the transmitter by simple software programming. This means that the sensor can be configured by the user for different ranges at any time.

Leaf Wetness Sensor

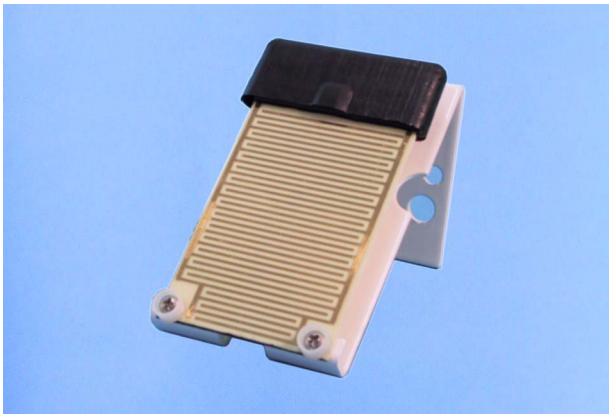


Figure 33 Leaf Wetness Sensor QLW101

Leaf Wetness Sensor QLW101 enables data logger to detect the presence of surface moisture on foliage and calculate the duration of wetness. When moisture is present, the sensor detects an electrical resistance change between the gold-plated elements of the grid.

Fuel Moisture/Fuel Temperature Sensor

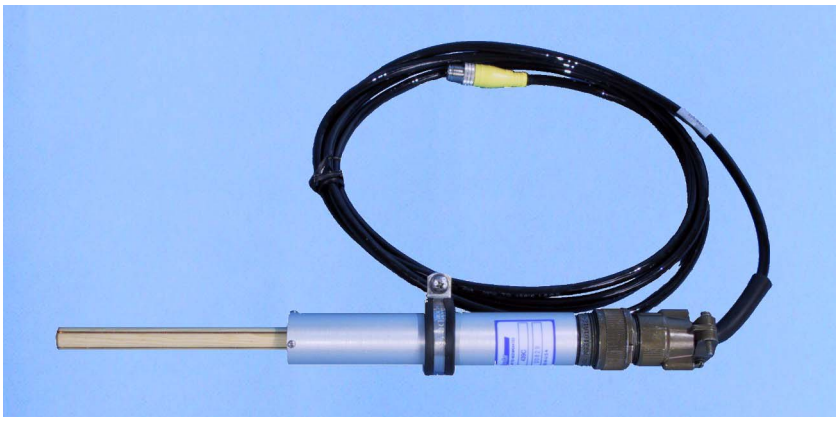


Figure 34 Fuel Moisture/Fuel Temperature Sensor

Fuel Moisture/Fuel Temperature Sensor measures the moisture content of the material on the forest floor or other natural area to help forest managers assess the fire danger. It uses a carefully selected and prepared pine dowel to exchange moisture with the environment. The

sensor measures the moisture content of the dowel by its electrical capacitance.

A thermistor, located in the dowel where it fastens to the base, measures the temperature of the dowel giving the estimated temperature on the forest floor.

CHAPTER 3
SELECTING LOCATION

This chapter provides information on siting the station and the sensors correctly.

Siting the Station

Finding a suitable site for the weather station is important for getting representative ambient measurements. Normally, the suitable site should represent the general area of interest. When locating the weather station, consider the items presented in the sections for each sensor. The descriptions are not exhaustive, for further information refer to local and WMO recommendations.

Combined Wind Sensor

Allow sufficient clearance for the wind sensor. Install the wind sensor away from buildings or any other objects that might affect the airflow.

In general, any object of height (h) will not remarkably disturb the wind measurement at a minimum distance of 10 × h. There should be at least 150 m (500 ft.) open area to all directions from the mast. Refer to Figure 35 on page 50.

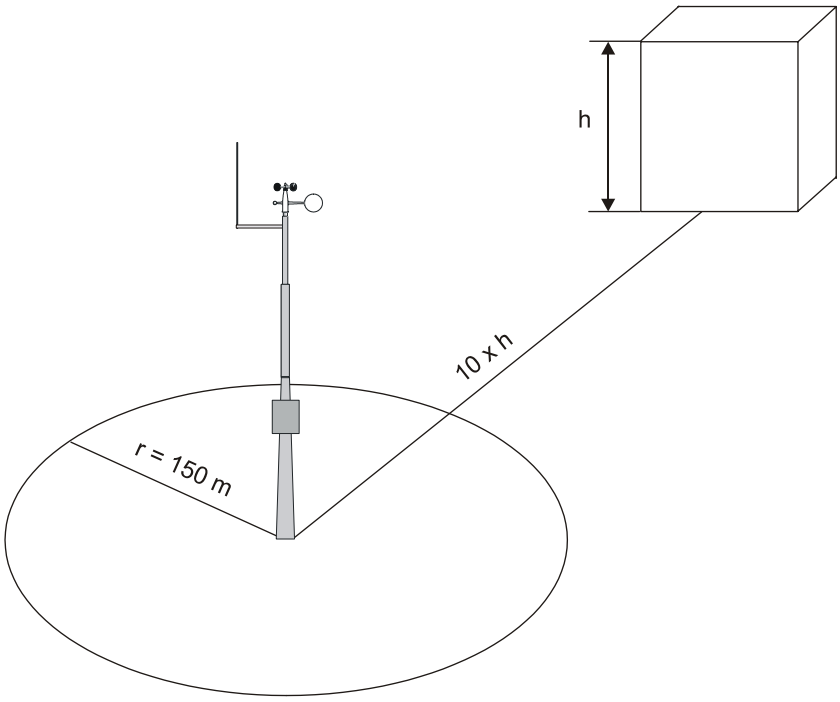


Figure 35 Recommended Mast Location in Open Area

The recommended minimum length (h in Figure 36 on page 50) for the mast that is installed on the top of a building is 1.5 times the height of the building (H). When the diagonal (W) is less than the height (H) the minimum length of the mast is 1.5 × W.

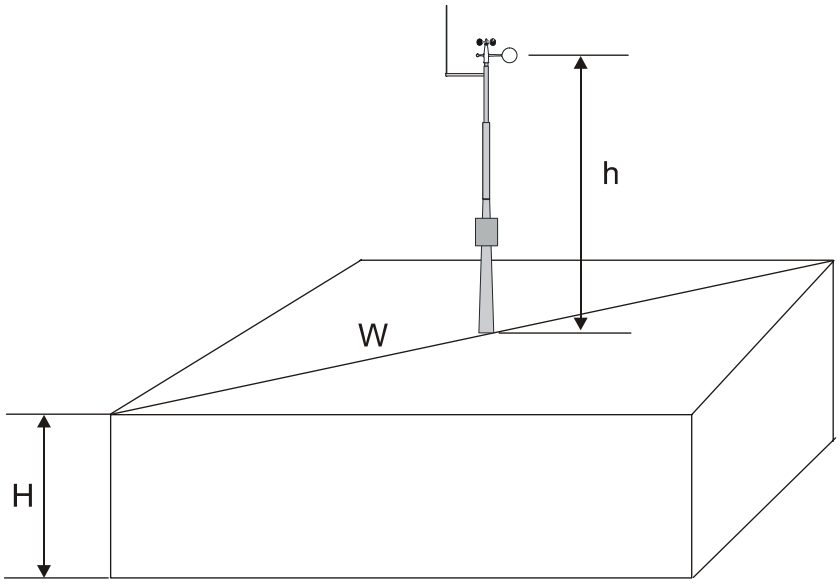


Figure 36 Recommended Mast Length on the Top of a Building

Air Temperature and Relative Humidity Sensor

Finding a suitable site for the Air Temperature and Relative Humidity Sensor is important for getting representative ambient measurements. The site should represent the general area of interest.

NOTE	The radiation shield is important in protecting the sensor from direct sunlight and must always be used.

The recommended height for the sensor is from 1.5 to 2 meters (from 5 to 6.5 ft.) from ground or the height defined with the applicable mast construction. Install the sensor so that direct sunlight to the sensor is avoided.

Avoid the following installation sites to ensure correct measurements: shaded areas, rooftops, steep slopes, heat sources, swamps, high vegetation, and places that might hold water after rains.

Rain Gauges

The opening of the gauge must be in a horizontal plane, open to the sky, and above the level of in-splashing and snow accumulation. In general, objects should not be closer to the gauge than a distance twice their height above the gauge opening.

In areas of homogeneous dense vegetation, the height of the vegetation should be kept below the gauge opening level by regular clipping. Sites on a slope or on the roof of a building should be avoided. Also hard flat surfaces such as concrete should be avoided to prevent splashing.

Pyranometers

Finding a suitable site for the solar radiation sensor is important for getting representative ambient measurements. The site should represent the general area of interest.

Make sure that no building or object will shadow the solar radiation sensor, during the day.

On the Northern Hemisphere, the solar radiation sensor should be installed on the southern side of the mast (on the Southern Hemisphere,

vice versa) to avoid other objects shading the sensor. To facilitate leveling/cleaning, installing at a height of 3 m (10 ft.) or less is recommended.

Net Solar Radiation Sensor

Finding a suitable site for the product is important for getting representative ambient measurements. The site should represent the general area of interest.

On the Northern Hemisphere, the Net Solar Radiation Sensor should be installed on the southern side of the mast (on the Southern Hemisphere, vice versa) to avoid other objects shading the sensor. It is recommended to install the sensor at least 1.5 meters (5 ft.) above the surface in order to avoid shading effects and to promote spatial averaging. To facilitate leveling/cleaning, installing at a height of 3 m (10 ft.) or less is recommended.

Soil Temperature Sensor

Finding a suitable site for Soil Temperature Sensor is important for getting representative soil temperature measurements. Measurement site should be 1 m² and typical of the surface of interest. The ground surface should be level with respect to the immediate (10 m radius) area.

Always examine the soil properties to make sure that there are no sharp stones or other objects in the ground that could damage the fiberglass tube of the sensor.

Soil Moisture Sensor

Finding a suitable site for the product is important for getting representative ambient measurements. The site should represent the general area of interest.

The soil water content measured by the ML2x sensor within one small locality can be affected by:

- Variations in soil density and composition
- Stones close to the rods
- Roots (either nearby or pierced by the rods)

- Earth worm holes or mole holes
- Subsoil drainage
- Small scale variability in transpiration and evaporation losses.

It is important to take the degree of variability of these parameters into account when deciding on the number of probes to be used at any particular location. If the soil is known to be very heterogeneous, it will be necessary to take measurements from at least three closely-spaced locations.

Soil Moisture Sensor

Finding a suitable site for the product is important for getting representative ambient measurements. The site should represent the general area of interest.

When selecting a site for ECH_2O-M3 installation, it is important to remember that the soil adjacent to the probe surface has the strongest influence on the probe reading and that the probe measures the **volumetric** water content. Therefore any air gaps or excessive soil compaction around the probe can profoundly influence the readings. Also, do not install the probes adjacent to large metal objects such as metal poles or stakes. This can attenuate the probe's electromagnetic field and adversely affect output readings.

Submersible Water Level Sensor

Finding a suitable site for the product is important for getting representative ambient measurements. The sensor should always be protected against the flow and impurities in the river. Typically, the water level sensor is installed in a stilling well or inside a pipe for protecting the sensor against debris and vandalism.

Place the sensor according to the following examples. Refer to Figure 37 on page 54.

Example 1: Average water level is 25 meters (82 ft.) and maximum annual change is 50 cm (19.7 in.). Suitable sensor is with range of 75 cm (29.5 in.) and installation place is 24,6 meter (80.7 ft.) from ground level.

Example 2: In dry season the riverbed is dry and in rain season the ultimate water level is 7 meters (23 ft.). Suitable sensor would be with 10-meter (32.8 ft.) range. If interested values start after water level is greater than 3 meters (9.8 ft.), it is possible to use 5-meter (16.4 ft.) version and install it to 3 meters (9.8 ft.) from ground.

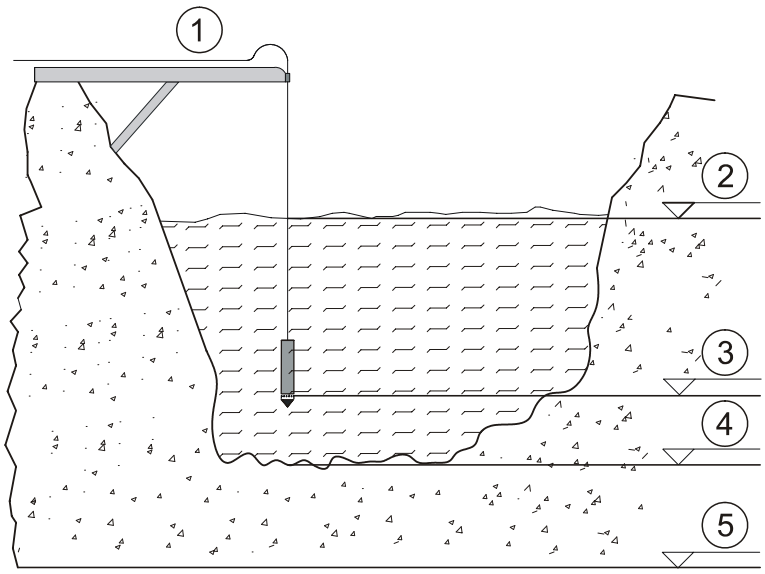


Figure 37 Water Level Sensor in Water

The following numbers refer to Figure 37 on page 54:

1 = Cable to a logger

2 = Water level

3 = Sensor level

4 = Local reference

5 = Common level

Leaf Wetness Sensor

Finding a suitable site for Leaf Wetness Sensor QLW101 is important for getting representative ambient measurements. The site should represent the general area of interest.

Fuel Moisture/Fuel Temperature Sensor

Finding a suitable site for the fuel moisture sensor is important for getting representative ambient measurements. The site should represent the general area of interest.

You should install the fuel moisture sensor 0.3 m (1 ft.) above the forest floor and orient the sensor parallel to the ground.

Fuel Moisture Sensor can monitor the moisture conditions on the forest floor only if it can absorb and give up moisture near a fair sample of the material that is naturally present. It must exchange moisture with the air the same way that the forest floor materials do.

Mount the sensor on the south side of the tower (or the north side in the southern hemisphere) so that it is not shadowed by the tower. If possible, arrange that the sensor is exposed to sunlight for at least six hours in the middle of the day. Make sure that no grass or other vegetation touches the sensor; these can transfer moisture directly. The sensor must be installed approximately one week before it can give accurate fuel moisture readings.

CHAPTER 4
INSTALLATION

This chapter describes how to install MAWS and the accessories and sensors connected to it.

For the installation instructions of the MAWS Terminal software and the setup software MAWS Lizard, see the MAWS Lizard User's Guide.

Preparing Installation

Make sure you have all the necessary tools at hand. The Tools Bag supplied with the tripod mast includes a set of tools that will be needed during installation. Tools needed:

- Compass (not supplied), or other methods to establish the right orientation of the station
- Screwdrivers: 3 mm (in the Tools Bag)
- Hex wrenches: 4 mm (in the Tools Bag)
- Hammer for hitting the ground pegs into ground (in the Tools Bag of the MAWS201 delivery)
- Pegs for securing the tripod (in the Tools Bag of the MAWS201 delivery).

Additional special tools for the different sensors are provided in their packages.

One person can complete the whole installation. Depending on the set of sensors, the installation should not take more than 1 to 2 hours.

Unpacking Instructions

When you have received the delivery, first see that you have all the ordered components. Secondly, check the sensors. Make sure that they have not been damaged during transportation.

User manuals and special tools included in the packages should be stored in a safe place for later use.

The logger electronics are attached to the railing inside the tube. The tripod is also already assembled, but it needs to be attached to the tube structure.

Installing Software

Installing Embedded Software

The embedded software on the logger is normally installed at the factory. For the instructions on installing a new, updated version, see the Software Loading Technical Notice.

Installing MAWS Terminal

For the instructions on installing the MAWS Terminal software to a PC, see the MAWS Lizard User's Guide.

Installing MAWS Lizard

For the instructions on installing the MAWS Lizard setup software to a PC, see the MAWS Lizard User's Guide.

Installing MAWS Basic Components

The installation of the basic components is done only when taking the MAWS weather station in use for the first time.

NOTE	The figures in this procedure present installing MAWS201. In case you are installing MAWS101, you do not have any of the tripod's parts attached as shown in some of the figures.

1. Loosen the hand screw (number 1 in Figure 38 on page 59) beneath the tube. Slide the tube down to expose the logger.

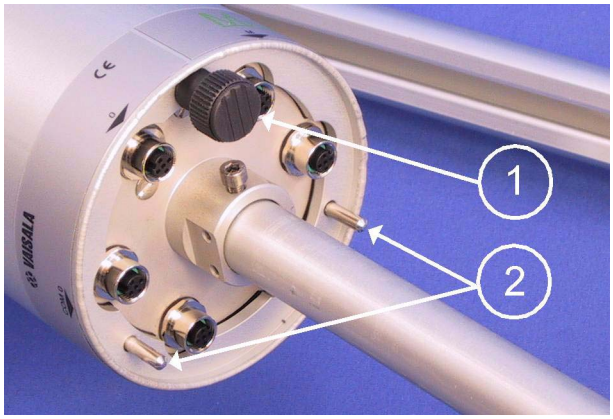


Figure 38 Tube Securing Hand Screw

2. Remove the logger cover screw (number 1 in Figure 39 on page 59) to open the logger housing.

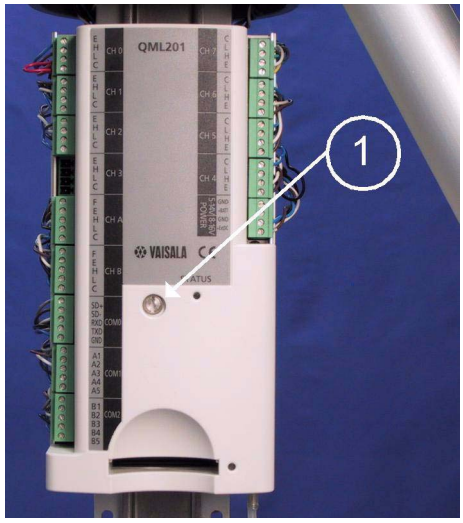


Figure 39 Logger Cover Screw

3. When you have the pressure sensor (number 1 in Figure 40 on page 60) installed on the logger, attach the tube that comes from the blue inlet (3) into the outlet (2) of the logger housing. The tube should

cover at least 5 mm of the outlet. Make sure that the tube is not blocked or bent during the transportation.

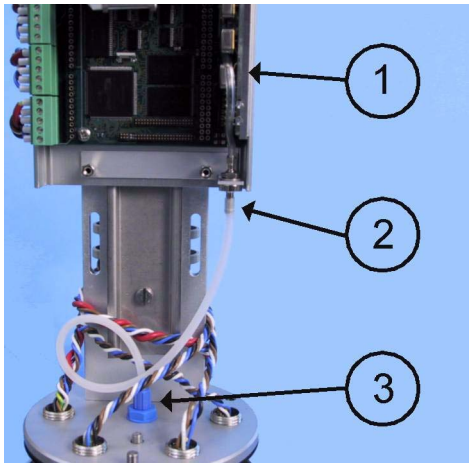


Figure 40 Pressure Sensor Tube Connection

4. The internal battery should always be installed when the weather station is in operation. The battery supplies backup power to the station and is needed for keeping the time and date information. To insert the internal battery, you may have to bend battery terminals. Connect the flat connectors to battery terminals (numbers 1 and 2 in Figure 41 on page 61). Connect the red wire to the positive pole (+), and the black wire to the negative pole (-). The battery lead(s) is disconnected during shipping. It is recommended to disconnect the lead also if the station is not used for several weeks (no charging). When storing the station for a few days, use **SLEEP** command to reduce the power consumption and discharge of the battery.

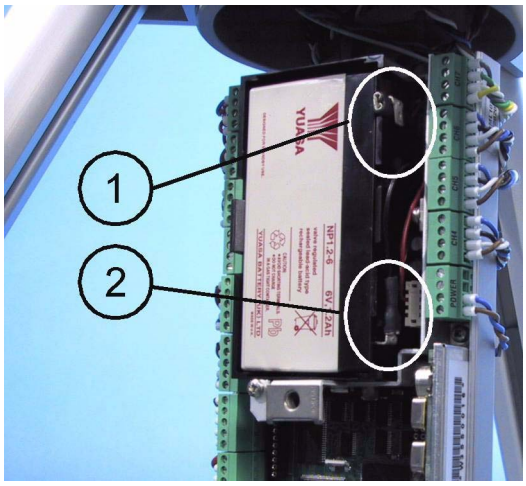


Figure 41 Battery Connectors

5. To install the additional Internal Battery, follow the procedure below:

   a. Bend the metal clip (number 2 in Figure 42 on page 61) at the top to hold the battery in its compartment.

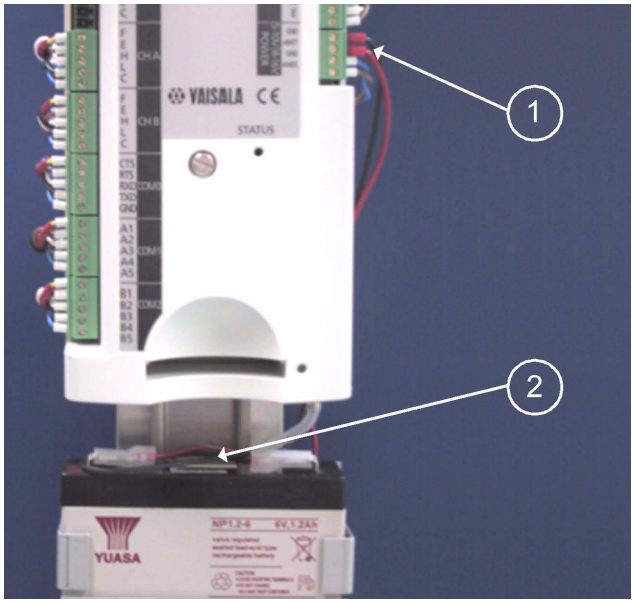


Figure 42 Additional Internal Battery Installed

   b. Install the battery on the DIN-rail below the logger. If more space is needed under the logger, you may move the logger slightly upwards.

CAUTION	Make sure that the pressure vent tube does not get blocked or bent

c. Connect the wires from the battery to the **Power** connector (number 1 in Figure 42 on page 61): the black wire to the **GND** connector and the red wire to the **Batt** connector.

d. After the installation is finalized, open the MAWS Terminal software. In the **Tools** menu, select **Station Settings** to change the capacity of the internal battery from 1.2 to 2.4 Ah.

6. To keep the tube watertight, the tube should cover the two O-rings (number 1 and 2 in Figure 43 on page 62) on the bottom of the upper base. Rotate the tube to find the aligning pins (number 2 in Figure 44 on page 62) position. Slide the tube up. Tighten it with the hand screw (number 1 in Figure 44 on page 62).

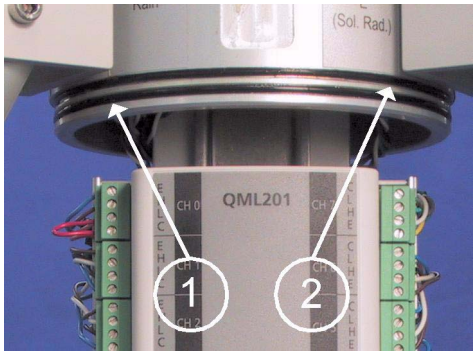


Figure 43 O-rings for Sealing the Tube

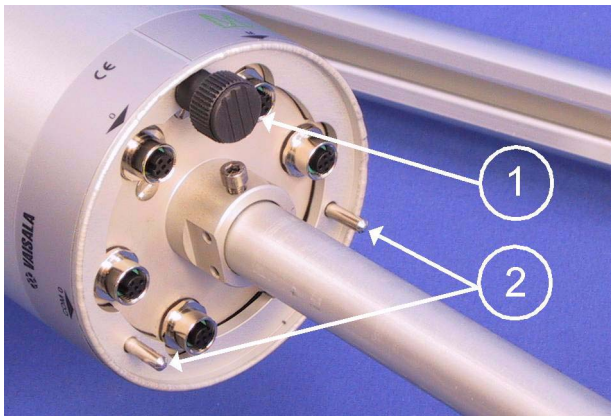


Figure 44 Hand Screw and Aligning Pins

7. Normally the tripod is fully assembled at the factory, but when not, attach the leg fasteners (number 1 in Figure 45 on page 63) to the upper base. Lock the leg (2) to the leg fastener with a bolt (3).

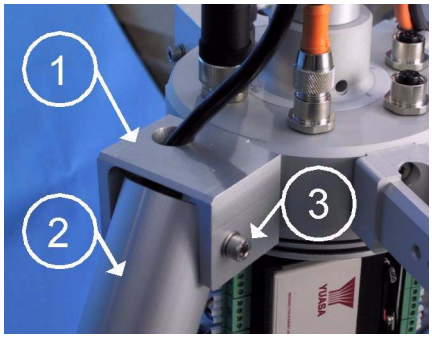


Figure 45 Tripod's Leg Attachment

8. Attach the wind sensor adapter to the top of the wind/telescope mast (if not already attached). Tighten with the small hex screw (number 1 in Figure 46 on page 63). Guide the wind sensor cable through the upper tube and connect it to the sensor. The sensor is affixed into its place by tightening the plastic collar (2).

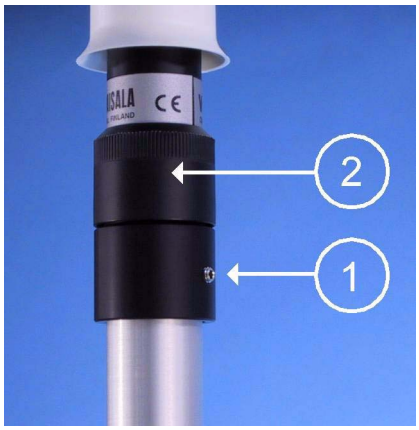


Figure 46 Wind Sensor Adapter Attachment

9. Attach the sensor arm supports (number 1 in Figure 47 on page 64) to the upper base. Tighten the screw properly with an appropriate tool (2).

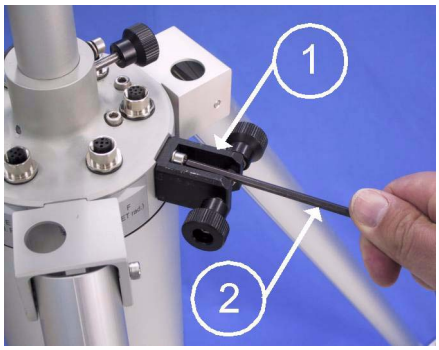


Figure 47 Sensor Arm Support Attachment

Installing MAWS201 Tripod

MAWS201 always has a tripod for supporting the logger tube, as well as one or more sensor arms that are connected to the tube. The legs of the tripod are adjustable. The pegs should be used to prevent the tripod from collapsing. For the wind sensor installation there is the wind mast or telescope mast attached to the upper base of the logger tube. The schematic structure of the installed MAWS201 is presented in Figure 48 on page 65.

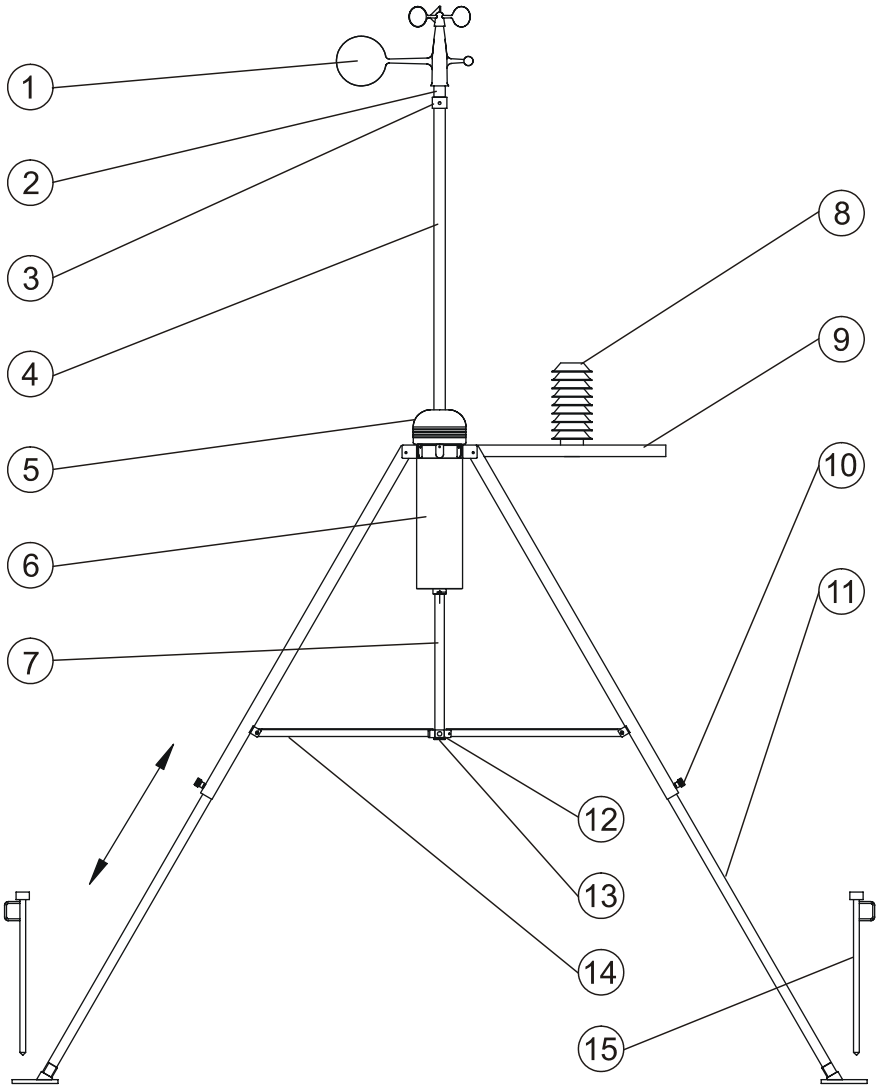


Figure 48 Mechanical Structure of MAWS201

The following numbers refer to Figure 48 on page 65:

1 = Wind sensor
2 = Plastic collar
3 = Mounting piece
4 = Wind mast / Telescopic mast
5 = Protection cover
6 = Tube
7 = Support tube
8 = Radiation shield

9 = Sensor arm
10 = Hand screw
11 = Telescopic leg
12 = Locking ring and hand screw
13 = Pressure port
14 = Support bar
15 = Ground peg

Installing Power Supply

Installing Solar Panel

WARNING	Photovoltaic modules generate direct current (DC) when exposed to sunlight or other sources of light. Although single modules produce low voltage and current, shocks and burns can still result from contact with module output wiring. PV modules do not have to be "connected" (that is, powering a load) to generate electricity. Since modules produce electricity whenever light is present, the module should be completely covered by an opaque cloth or other material before electrical connections to the modules or other system components are handled.

WARNING	When working with modules, use properly insulated tools and wear rubber gloves.

CAUTION	Handle with care: impact on the front or rear surface can damage the module. Do not bend the module.

NOTE	Do not concentrate light on the module in an attempt to increase its power output.

Usually the solar panel is installed at the factory, and you should only adjust the tilt angle and check that the connector is attached. In case you need to install the solar panel, follow the procedure below:

1. Locate the leg where the solar panel is to be installed. The correct leg is the one having **DC Power Input** label on the left side. Also note the alignment of sensor arms versus solar panel.
2. Place the solar panel towards the leg approximately 40 cm (1.3 ft.) down from the upper plate of the tripod. Make sure that the shelf (number 1 in Figure 49 on page 67) fits to the leg profile (2). When the panel is at suitable height, tighten the hand screw (3).

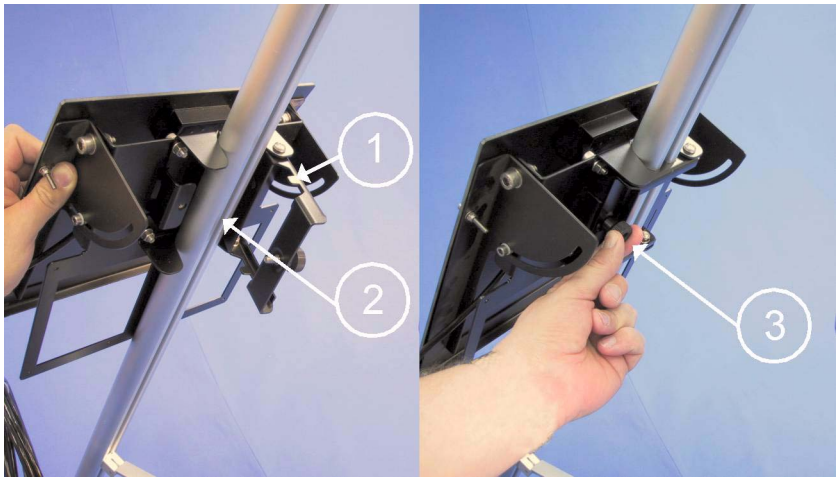


Figure 49 Solar Panel Fixture

3. Open the bolt (number 3 in Figure 50 on page 67) of the leg fastener (1) to release the leg (2). Fit the cable inside the leg and guide it through the hole in the leg fastener. Put the leg back into the leg fastener and tighten the bolt (3). Attach the cable to the **DC Power Input** connector.

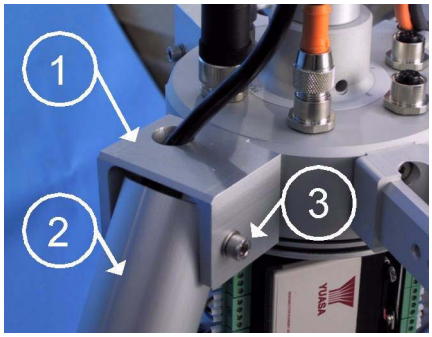


Figure 50 Tripod's Leg Attachment

4. Thread the cable through the connector parts in the indicated order 1-2-3-4. Parts for a metallic connector are shown in Figure 51 on page 68. Parts for a plastic connector are shown in Figure 52 on page 68.

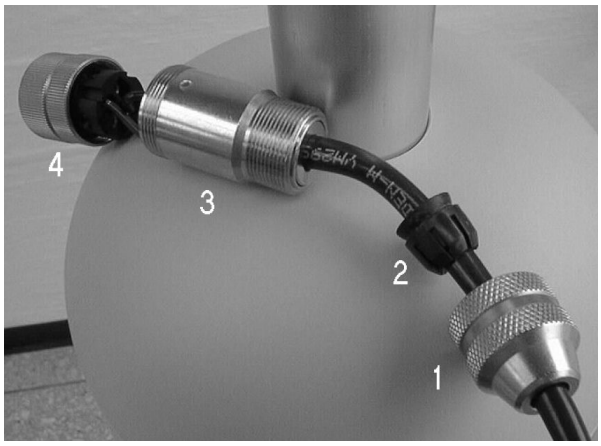


Figure 51 Metallic Connector for Solar Panel

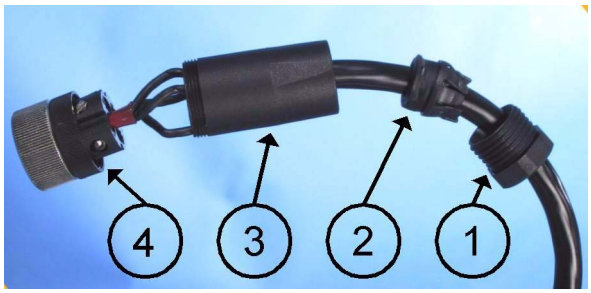


Figure 52 Plastic Connector for Solar Panel

5. Insert the wires numbered 1 and 2 into the terminal 1 and the wires numbered 3 and 4 into the terminal 3. Tighten the screws that hold the wires.

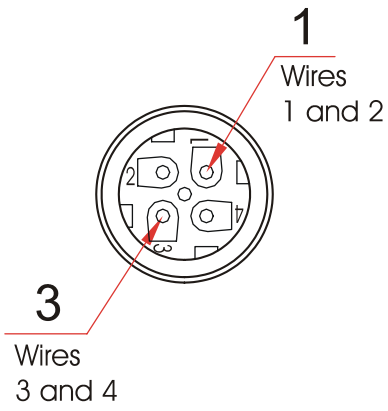


Figure 53 Wires' Connection to the Terminals

NOTE	In the figures only the metallic connector is presented, although the procedure is the same with the plastic connectors.

6. Tighten part 3 to connect it with part 4, see Figure 54 on page 69. Insert the sealing part 2 into part 1. Tighten part 1 to part 3.

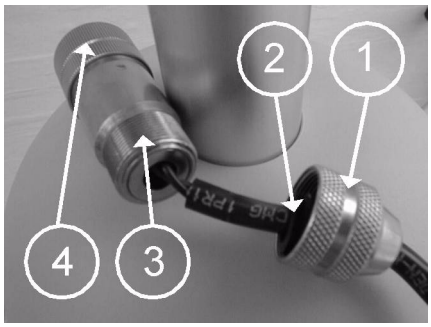


Figure 54 Solar Panel Connector Assembly

7. Attach the plug to the **Solar** connector by tightening the lowest nut.
8. Adjust the angle of the solar panel.

Installing a QMP Power Supply

Optionally MAWS can be powered from a QMP power supply.

Mains Power Supply QMP213

Mains Power Supply QMP213 is delivered with the U-bolts, washers, nuts, and the connector cable for MAWS. The unit is attached to the mast.

It is mountable to a Ø 60 mm or 100 mm pole mast as well as to one of the tripod legs of the MAWS201 weather station.

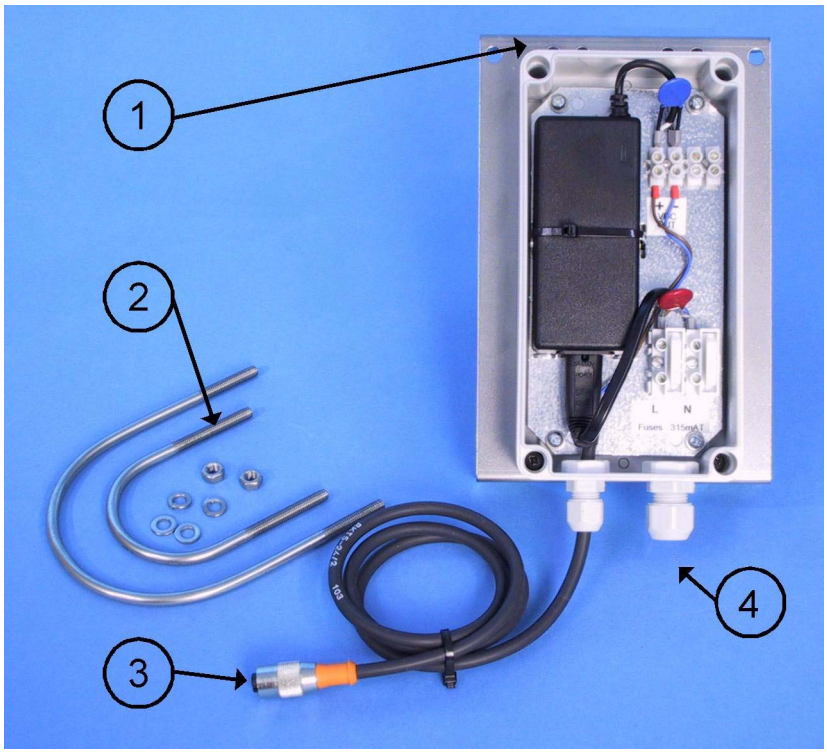


Figure 55 QMP213 with Installation Accessories

To install the unit, follow the procedure below:

1. Attach the unit through the holes in the upper end (number 1 in Figure 55 on page 70) with the provided accessories (2) to the mast. The cable inlets should face down.
2. Lead the mains power cable through the opening (4) and connect the wires under the screws into the locations marked with L and N. Tighten the inlet nut properly.
3. Connect the output power cable (3) to the power connector of MAWS.

Solar/Mains Power Supply QMP201C

Solar/Mains Power Supply QMP201C is delivered with a connector cable for MAWS. The unit is attached to the tripod's leg.

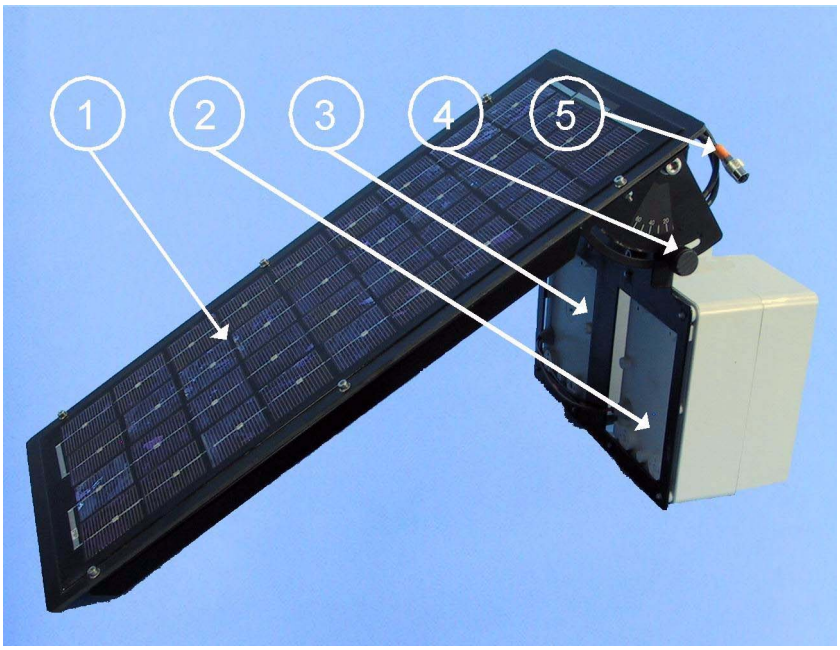


Figure 56 Parts of QMP201C

The following numbers refer to Figure 56 on page 71:

1 = Solar panel

2 = Backup battery box

3 = Mains power supply and battery regulator box

4 = Angle adjusting hand screw

5 = Connector cable

To install the unit, follow the procedure below:

1. Locate the leg where the solar panel is to be installed. The correct leg is the one having **DC Power Input** label on the left side. Also note the alignment of sensor arms versus solar panel.
2. Place the solar panel towards the leg approximately 40 cm (1.3 ft.) down from the upper plate of the tripod. Make sure that the shelf (number 1 in Figure 57 on page 72) fits to the leg profile (2). When the panel is at suitable height, tighten the hand screw (3).

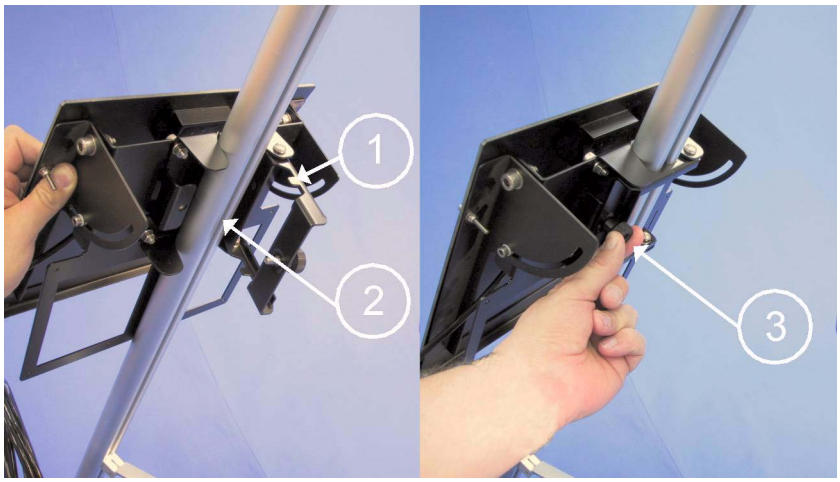


Figure 57 Solar Panel Fixture

3. Open the bolt (number 3 in Figure 58 on page 72) of the leg fastener (1) to release the leg (2). Fit the cable inside the leg and guide it through the hole in the leg fastener. Put the leg back into the leg fastener and tighten the bolt (3). Attach the cable to the **DC Power Input** connector.

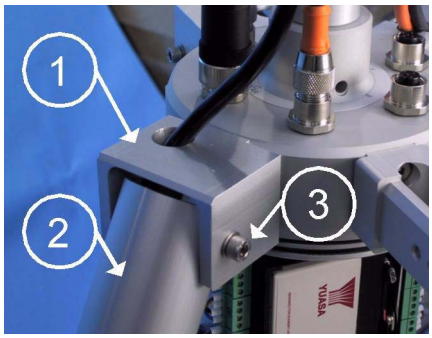


Figure 58 Tripod's Leg Attachment

4. Adjust the angle of the solar panel.

Connecting Cables

After installing the sensors mechanically, follow the instructions in the steps below to connect the cables. Step 1 is for the lower base of the tube and step 2 for the upper base of the tube.

For detailed wiring instructions and diagrams, refer to Wiring Instructions on page 210 under Chapter 8, Technical Data, on page 207.

NOTE Be careful when connecting cables so that the connector pins will not bend.

NOTE After connecting the cables, configure the sensors and auxiliary devices with the MAWS Lizard Setup software. For more information, refer to the MAWS Lizard User's Guide.

1. Connect cables to the connectors on the upper base and tighten the screw nuts. For connector description, see Table 5 on page 73.

Table 5 Default Upper Base Connectors

Connector	Sensor/Device
(A) Temp/Humidity	QMH101 (HMP45) or WXT510
(B) Wind	QMW101 or QMW110 (WMS302)
(C) DC Power Input	Power supply (solar panel or mains power)
(D) Rain	QMR101 or QMR102
(E) Sol. Rad.	QMS101 or QMS102
(F) NET Rad.	QMN101

2. Connect the sensor cables to the connectors on the lower base and tighten the screw nuts. For connector description, see Table 6 on page 73.

Table 6 Default Lower Base Connectors

Connector	Sensor/Device
(H) COM0	Terminal
(I) COM1	Communications or sensors with RS-485 interface
(K) MOD1	Communications or sensors with serial interface
(L) Soil Temp.	QMT103 or QMT107
(M)	Additional sensor
(O)	Additional sensor

3. Finally, lower the protection cover on the upper base to shield the connectors.

Installing Communication Devices

Communication Modules

Modules can be attached on the circuit board to provide additional communication channels for MAWS. For the placement of the modules, see Figure 59 on page 74. The modules can simply be pushed on the connector blocks MOD1 and/or MOD2. Module options include DSU232, DSI485A, DSI486, and DMX501. By default, the modules are installed as described in Table 7 on page 74.

Table 7 Default Configuration for Communication Modules

Module	Connector Block	Port
DSU232	MOD1	MOD1
DSI485A / DSI486	MOD2	MOD2
DMX501	MOD2	MOD2

CAUTION When inserting modules, be careful not to bend the connector pins.

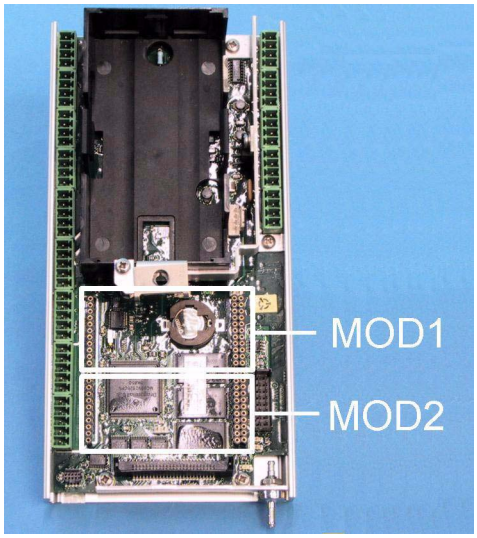


Figure 59 Module Placement

UHF Radio Modem

The radio modem SATELLINE 3AS comes with a ready-made cable (approx. 0.5 m, 20 in.) and a special weatherproof enclosure.

Follow the procedure below to install the radio modem SATELLINE 3AS to the sensor arm:

1. Install either an additional sensor arm with radio modem fixture or use an existing sensor arm that already has the radio modem fixture.
2. Install the radio modem to the fixture, see Figure 60 on page 75.

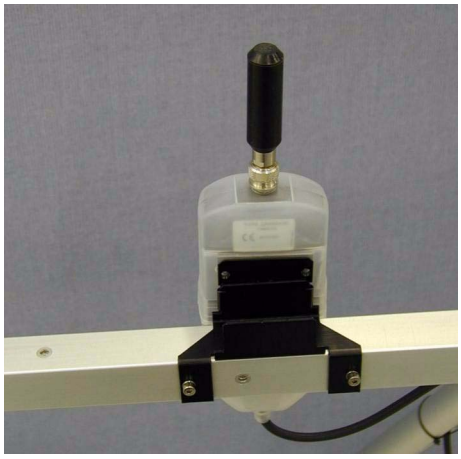


Figure 60 Radio Modem and the Fixture

Weather Transmitter

Unpacking Instructions

Weather Transmitter WXT510 comes in a custom shipping container. Be careful when removing the device from the container.

CAUTION	Beware of damaging any of the wind transducers located at the top of the three antennas. Dropping the device can break or damage the transducers. If the antenna bends or twists the re-aligning can be difficult or impossible.

Assembling WXT510

1. Turn out the top of the transmitter.
2. Remove the protective cap.
3. Replace the top and tighten the three fixing screws that fasten the top and the bottom.

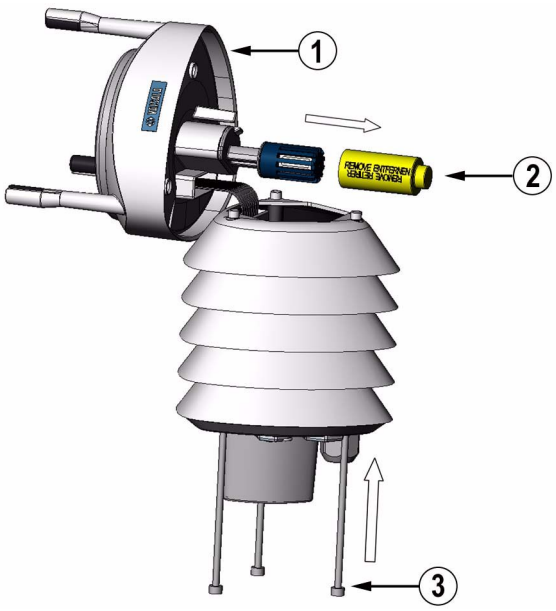


Figure 61 Assembling the WXT510

Air Temperature and Relative Humidity Sensor

Install the Air Temperature and Relative Humidity Sensor in the following way:

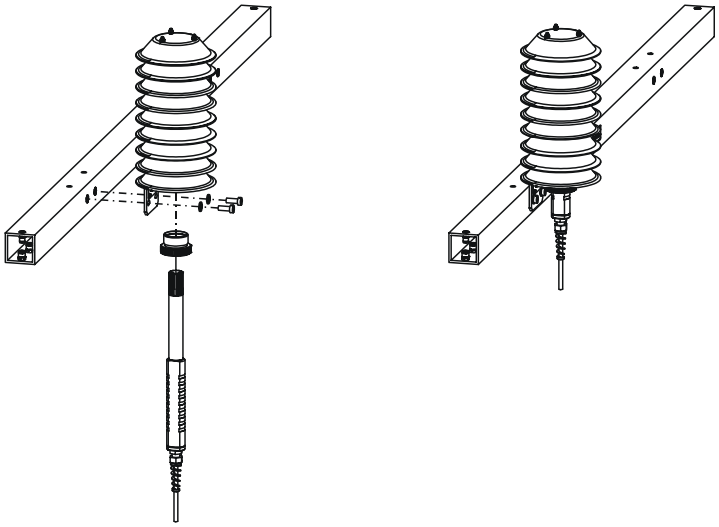


Figure 62 Radiation Shield and Sensor Installation

1. Install the radiation shield with the support on the mounting arm using the two screws.
2. Slide the temperature and humidity probe into the shield through the fastening ring.
3. Tighten the fastening ring.
4. Guide the sensor cable through the sensor arm opening.
5. Connect the signal cable to the data logger.

Pressure Sensor

The Pressure Sensor PMT16A is located on the CPU board of the logger, see Figure 63 on page 78. Normally, it is factory installed on the logger board. If necessary, it can be accessed by removing the cover of the logger. The sensor is connected directly into the connector on the board and is fixed on it with one screw.

CAUTION	When handling the sensor, take care not to bent any components on the transducer board.

CAUTION	Beware of electrostatic discharge when touching objects inside the logger housing.

CAUTION	Make sure that the vent tube of the pressure sensor is not blocked or bent during transportation.

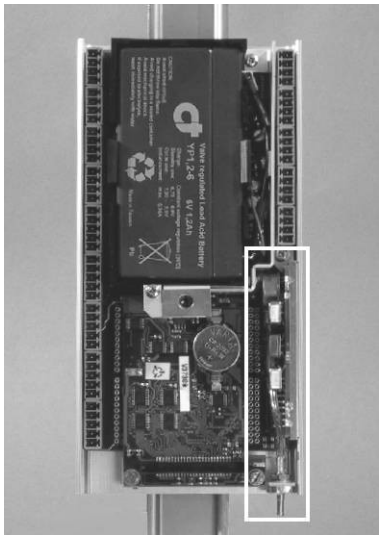


Figure 63 PMT16A Location on the Logger

Rain Gauges

Installation Procedure of QMR101

Usually, rain gauge QMR101 is installed on the same sensor arm with the temperature and humidity probe. QMR101 should be attached to a sensor arm in the following way:

1. Attach the mounting plates (1) to the sensor (2), if not already in place.

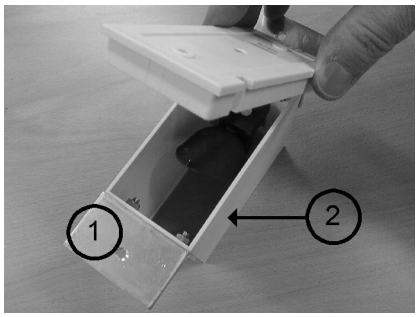


Figure 64 Mounting Plates Attachment

2. Attach the rain gauge (1) to the arm with the screws (2) provided with the rain gauge.

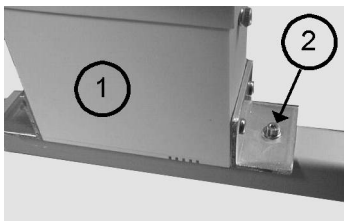


Figure 65 Rain Gauge Attachment

Installation Procedure of QMR102

Rain gauge QMR102 can be installed on the ground, on a base plate, or on a separate stand near the logger. Due to the low weight of the rain gauge, it must be mounted securely. QMR102 can be installed either using a specific stand RG35003 or on the ground when it is attached to a properly anchored RGB1 base plate with provided studs. As well, the

gauge can be mounted via the three holes in the base, for example, to a paving slab. You should use rawl plugs and standard steel studs for this purpose as they provide a means of leveling the rain gauge.

Installing on the Stand RG35003

To install the gauge on the stand, follow the procedure below:

1. Attach the stand (3) to a concrete foundation with the bolts (5). See Figure 66 on page 80.

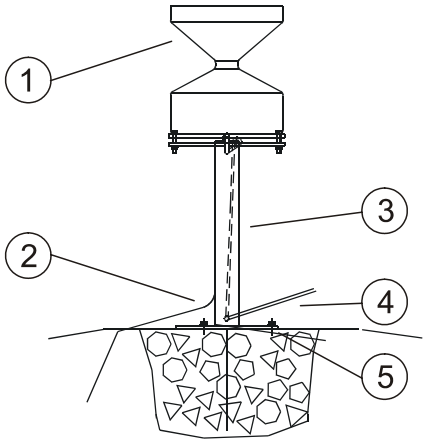


Figure 66 Rain Gauge Installed on a Stand

2. Mount the gauge (1) to the upper plate of the stand using the provided hardware. For an example, see Figure 67 on page 81.

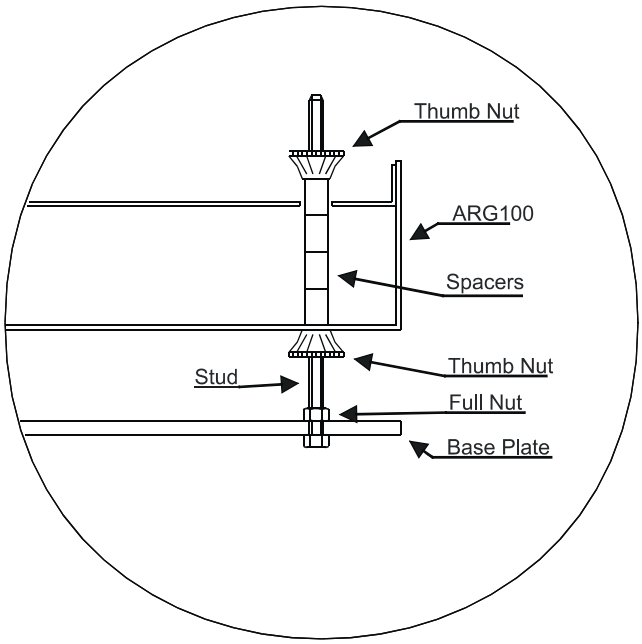


Figure 67 Rain Gauge Attachment

3. Connect the grounding cable (2).
4. Connect the signal cable (4) to a data logger.
5. Continue from section Finalizing the Installation on page 83.

Installing on the Base Plate RGB1

1. Use the base plate RGB1 as instructed in the provided data sheet.
2. Connect the signal cable to a data logger.
3. Continue from section Finalizing the Installation on page 83.

NOTE The base plate may be mounted to hard surfaces like concrete by replacing the pegs with screws and rawl plugs. For temporary mounting on hard surfaces use heavy weights on the four corners of the base plate. The height of the weights should be kept as low as possible to cause the minimum interference with the aerodynamics of the rain gauge.

Installing on a Pedestal

1. Drill out three holes in the base to the 6.5 mm in diameter and clean off burr. For details, see Figure 68 on page 82.
2. For the pegs, drill out a hole in the each corner of the pedestal plate. Clean off burr.

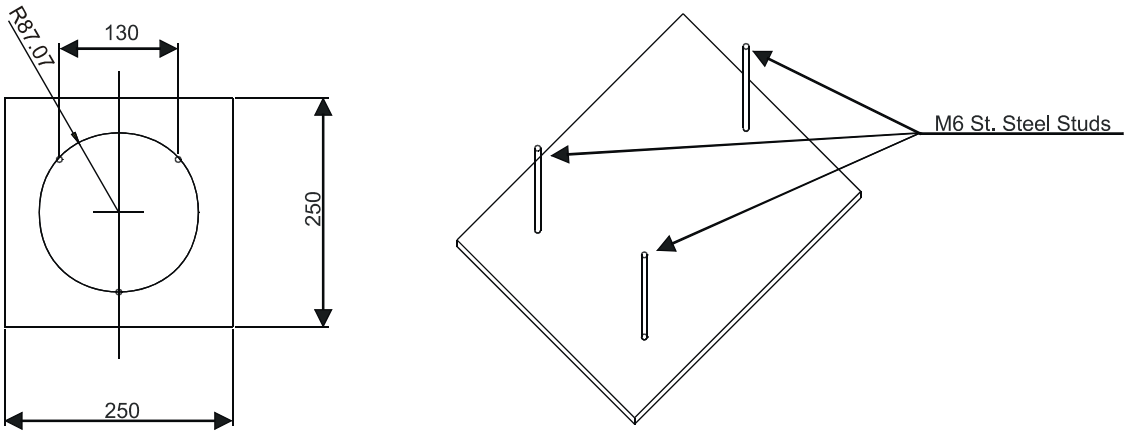


Figure 68 Rain Gauge Pedestal Plate Dimensions

3. Place the pedestal plate with rain gauge assembly on the ground using the pegs supplied. If force is needed, then remove the rain gauge first. See Figure 69 on page 82.

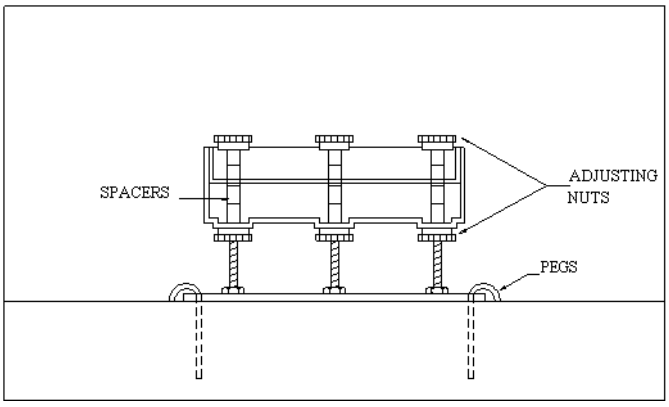


Figure 69 Assembling QMR102 on the Ground with Pedestal Plate

4. Connect the signal cable to a data logger.
5. Continue from section Finalizing the Installation on page 83.

Finalizing the Installation

Finalize the installation as described in the following steps:

1. To be able to release the rain gauge's tipping bucket mechanism, and adjust the level, first remove the funnel from its base by unscrewing the three plastic thumbscrews (1). See Figure 70 on page 83.

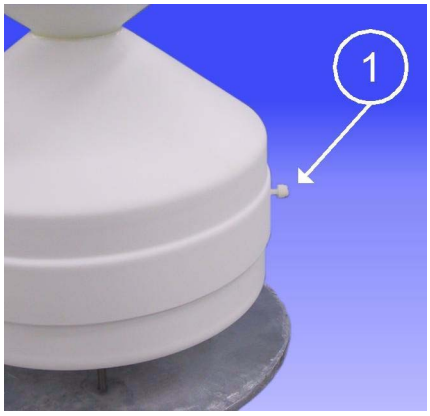


Figure 70 Funnel Fixing Screw

2. Remove the piece of foam (2) from under the bucket mechanism. This foam may be saved and used whenever the rain gauge is moved. See Figure 71 on page 83.

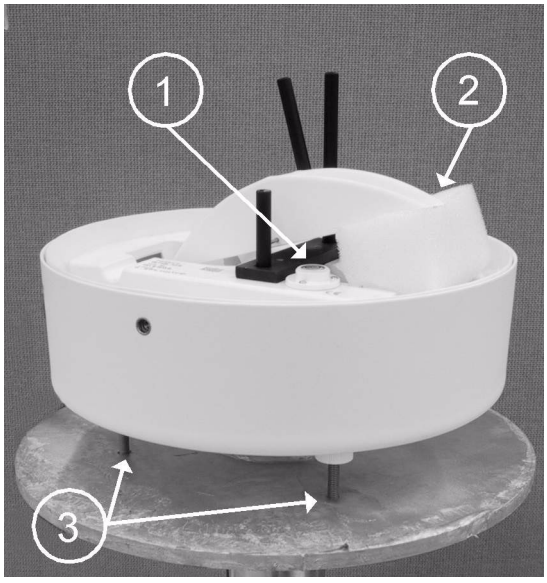


Figure 71 QMR102 Adjustment and the Foam Location

3. It is important to ensure that the rim of the rain gauge is leveled precisely. Failure to do this will result in a systematic error. Use a spirit level (1) and adjust with the fixing screws (3). See Figure 71 on page 83.
4. The cable length can be shortened or lengthened as required. If the cable is lengthened, please ensure a good quality environmental connector, or a heatshrink joint (see Figure 72 on page 84). Extension cables used must be of a similar specification.

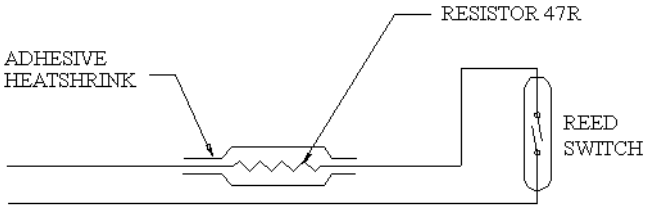


Figure 72 Wiring Diagram of QMR102

NOTE	When using QMR102, the shield must be connected to the ground.

Pyranometers

The pyranometer can be installed on the sensor arm as follows:

1. Attach the pyranometer (2) to the sensor arm (1) using the bolts (3) provided. For the explanation of the numbers, see Figure 73 on page 84.

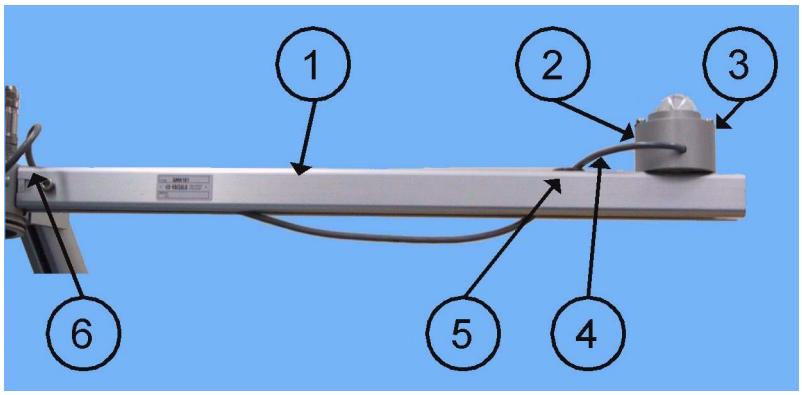


Figure 73 Installing Pyranometer on Sensor Arm

2. Lead the cable (4) through the sensor arm (5). Guide the sensor cable through the sensor arm opening (6).
3. After you have installed the sensor, connect the signal cable to the applicable connector of the host unit.

Net Solar Radiation Sensor

Install the sensor to the sensor arm as follows:

1. Attach the mounting piece (1) to the sensor arm (2). Tighten with the screws. For the numbers, see Figure 74 on page 85.

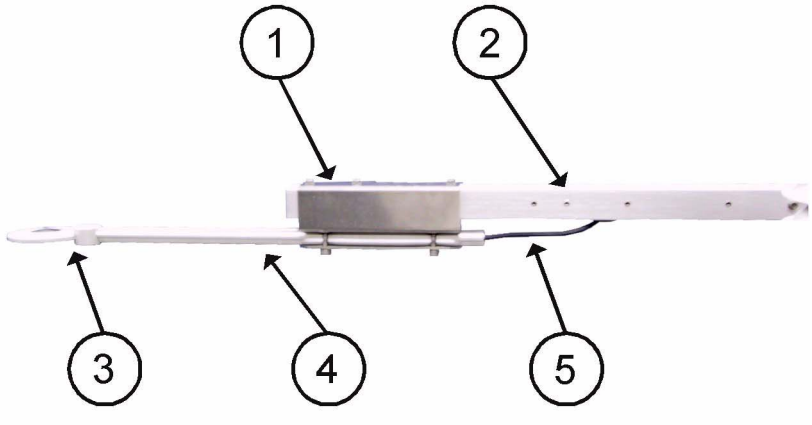


Figure 74 Installing Net Solar Radiation Sensor

2. Attach the Net Solar Radiation Sensor (3) to the extension arm (4). Attach the sensor's extension arm (4) to the mounting piece (1). Tighten with the screws.
3. Lead the cable (5) through the sensor arm (2). Guide the sensor cable through the sensor arm opening.
4. After you have installed the sensor, connect the signal cable to the applicable connector of the logger.

Soil/Water Temperature Sensors

Installation Procedure for QMT103/ QMT110

The QMT103/QMT110 sensor has the cable with the connector. The length of the cable defines the maximum distance from the logger. You can install the sensor either in soil or in water.

1. Choose a desired location for the sensor. Assure that the sensor is located within cable length of the logger enclosure.
2. To install the sensor in the soil:
    a. Make a hole with a shovel to a depth a little deeper than desired installation depth of the sensor.
    b. To get good sensor contact with the soil, position the sensor horizontally into the hole and push the sensor into the wall of the hole to the desired depth until set firmly.
    c. Fill the hole with the digged soil.
    d. Connect the cable to the logger enclosure.
3. To install the sensor in water:
    a. Make a solid base for the sensor to the desired installation depth in water.
    b. Position the sensor firmly to the base.
    c. Connect the cable to the logger enclosure.

Installation Procedure for QMT107

During a typical installation, the QMT107 sensor is pressed into pre-formed holes, but it can also be placed into excavated hole that is then filled. On hard or rocky ground, a pilot hole is pre-formed with an auger rod.

Drilling a Hole for the Sensor

Drill a hole according to the following procedure:

1. Choose a desired location for the sensor. Assure that the hole is located within cable length of the logger enclosure.
2. Drill a hole into the ground with the auger held as straight as possible. After you have drilled about 0.2 m (8 in.), extract the auger from the hole.

CAUTION The installation hole must be straight. Otherwise the sensor may bend, and the resulting tension damages the sensor.

CAUTION Do not use a hammer to pound the auger into ground even if the ground is hard or especially when it is rocky.

NOTE With fluid or loose soils there is risk of soil collapsing into the hole. To prevent this you can use a plastic or metal tube to assist the installation. After you have installed the sensor, remove the tube. Fill the gap with sand, mould, or other fine-grained soil with no sharp stones.

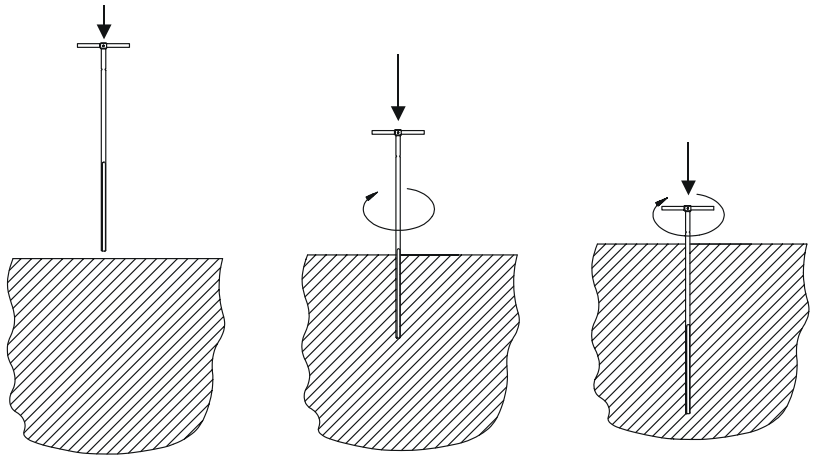


Figure 75 Drilling Procedure

3. Remove soil from the auger, for example, with a screwdriver not with fingers. Refer to Figure 76 on page 88.

WARNING Do not use fingers to clean the auger. The edges are sharp.

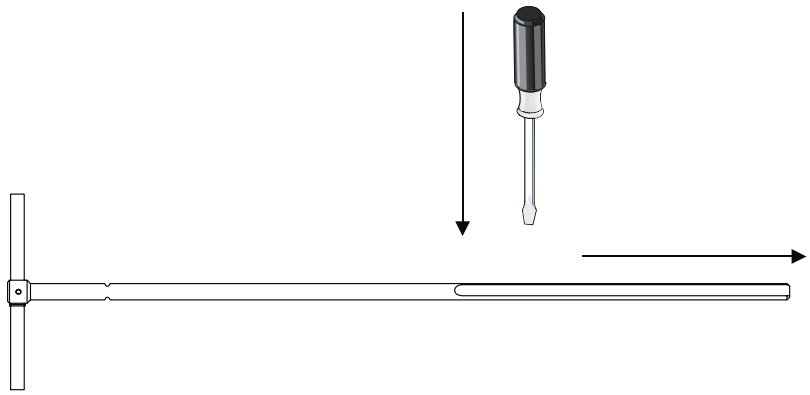


Figure 76 Cleaning the Auger with a Screwdriver

4. Repeat steps 2 and 3 until you have reached the desired depth. The maximum drilling depth is approximately 1.15 m (45 in.).

Inserting the Sensor into a Hole

Insert the sensor into the hole according to the following procedure:

1. Remove the auger from the hole.
2. Insert the sensor into the hole and press it down as deep as possible by hand. Make sure that there are no sharp stones or other objects in the ground that could press the sensor. Refer to Figure 77 on page 89.

CAUTION Do not drive or press sensors directly into soil of unknown composition. Always make a pilot hole prior to sensor insertion, unless the soil consists of homogenous, loose sand.

CAUTION Never use a hammer or other instrument to hit the sensor. If too much force is applied to the sensor, damage to the electronics inside may result. Note that sensor warranty is void if a hammer or unapproved tool is used to drive the probe into the soil.

CAUTION Make sure that there are no sharp stones or other objects in the ground that could press the sensor. Pressing objects can damage the fiberglass tube. Refer to Figure 77 on page 89.

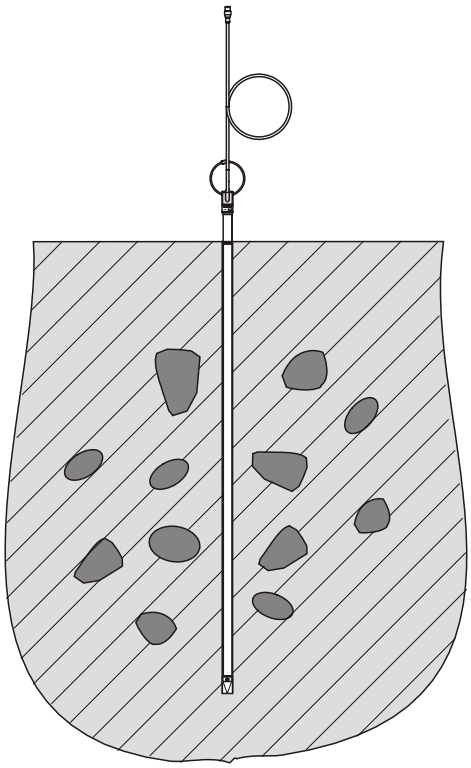


Figure 77 Sensor Installation in Rocky Soils

CAUTION Do not bend or flex the sensor during insertion or extraction.

NOTE Any delay in inserting the sensor into the drilled hole may allow moisture to swell the hole sides, or fill the hole with water.

NOTE Pack the soil around the sensor evenly, so that no vertical air slots are left between the sensor and the surrounding soil. Use installation sand or equivalent material for packing.

3. Insert the sensor deep enough into the soil so that the soil/air boundary is at the ground level line. The ground level line is marked on the sensor, see Figure 78 on page 90.

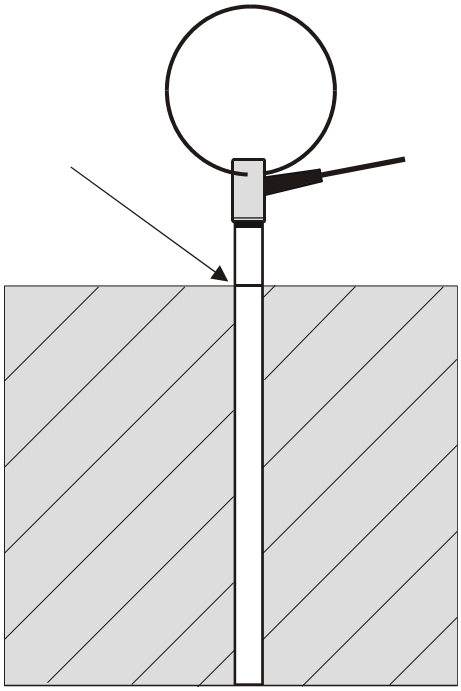


Figure 78 Soil Temperature Sensor Inserted Correctly, Arrow Pointing to Ground Level Line

4. Finally, connect the signal cable to the logger.

Extraction Procedure for QMT107

Follow the procedure below to extract the sensor, refer to Figure 79 on page 91.

CAUTION	If too much force is applied, damage to the electronics of the sensor may result.

NOTE	Small, gentle strokes are essential for extracting the sensor.

1. Set a piece of wood or similar close to the sensor.
2. Pass the auger rod through the wire loop at the top of the sensor.
3. Make the auger handle rest onto the piece of wood.
4. Lift the sensor.

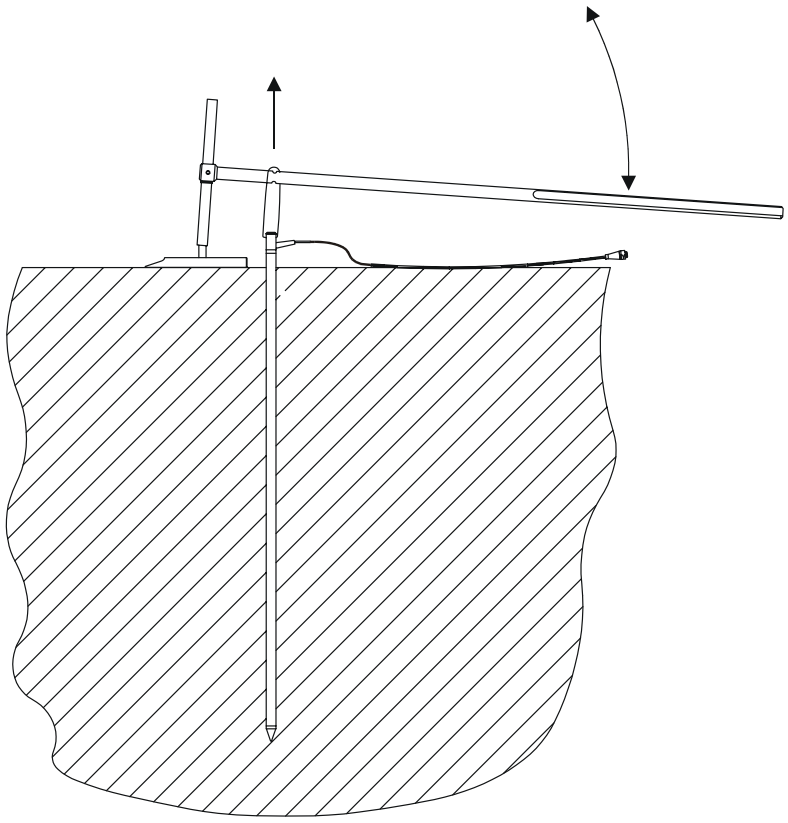


Figure 79 Sensor Extraction

Soil Moisture Sensor

The sensor can either be inserted or buried into the soil. To install the ML2x sensors, follow the procedure below:

1. Simply insert the ML2x sensor to soil as shown in Figure 80 on page 92. Assure that the measurement rods are fully inside the soil.

Figure 80 Soil Moisture Sensor ML2x

2. To bury the sensor in the soil, see Figure 82 on page 93:

   a. Make a hole with a shovel to a depth a little deeper than desired installation depth of the sensor.

   b. To get good sensor contact with the soil, position the sensor horizontally into the hole and push the sensor into the wall of the hole (to the direction of the arrow in Figure 81 on page 92) until the measurement rods are fully in the soil.

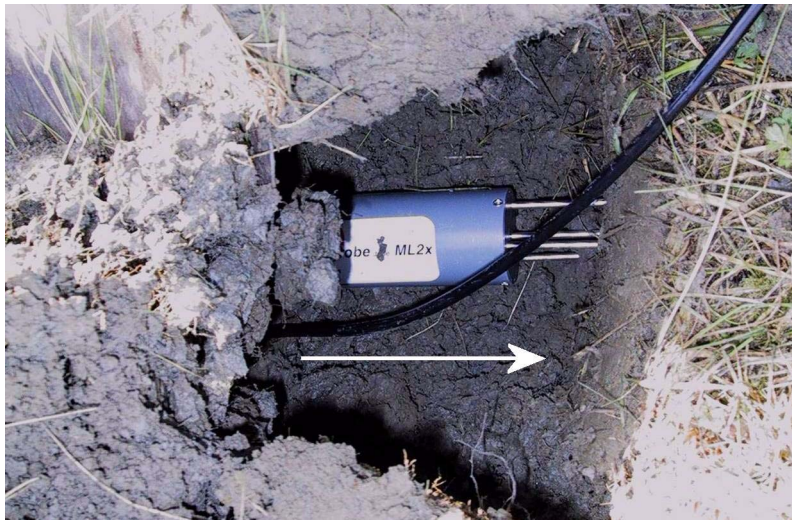


Figure 81 ML2x Sensor at the Bottom of the Hole

c. When several sensors are buried, refer to Figure 82 on page 93 for finalized installation.

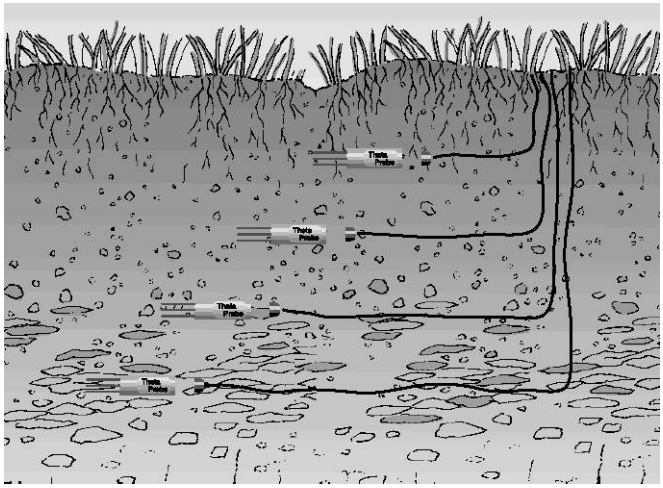


Figure 82 Buried ML2x Sensors

d. Fill the hole with the digged soil.

3. Pull the sensor cable(s) close to the logger enclosure.
4. Connect the signal cable to the applicable connector of the logger. If you have purchased a sensor without factory made connectors, see Wiring Instructions in the Technical Data chapter.

Soil Moisture Sensor

The probe can be oriented in any direction. However, orienting the flat side perpendicular to the surface of the soil will minimize effects on downward water movement. You can install the ECH2O-M3 sensor either shallow or deep:

1. For shallow installations:
   a. Simply cut a pilot hole in the soil using a shovel or flat blade that is approximately the thickness of the probe.
   b. Saturate the hole with water and insert the ECH2O-M3 sensor in the soil at the desired position, making sure the probe is oriented such that the flat side is perpindicular to the surface of the soil and make sure the entire length of the probe is covered.

c. Finally, insert the shovel again into the soil a few inches away from the probe, and gently force soil toward the probe to provide good contact between the probe and the soil.

2. For deeper installations:
   a. Excavate down to the level you wish to measure.
   b. In the exposed wall, cut a pilot hole as described above.
   c. Saturate the pilot hole with water.
   d. Insert the senor(s).
   e. With a shovel or blade a few inches away from the probe, squeeze the soil onto the probe. This will improve the soil-to-probe contact.
   f. Fill the hole with the digged soil preserving the original soil profile and compaction.
3. Pull the sensor cable(s) close to the logger enclosure.
4. Connect the signal cable to the applicable connector of the logger. If you have purchased a sensor without factory made connectors, see Wiring Instructions in the Technical Data chapter.

When removing the probe from the soil, do not pull it out of the soil by the cable. Doing so may break internal connections and make the probe unusable.

Submersible Water Level Sensor

Water level sensor has a ready-made cable and a connector. The length of the cable defines the maximum distance from the logger. You have to install the sensor on a solid fixture in water.

1. Choose a desired location for the sensor. Assure that the sensor is located within cable length of the logger enclosure.
2. Make a solid base for the sensor to the desired installation depth in water.
3. Position the sensor firmly to the base.
4. Connect the cable to the logger enclosure.

Leaf Wetness Sensor

Installation Procedure

Leaf Wetness Sensor is delivered with an installation hardware kit and a sensor cable.

Initial Check

You may test the sensor before you install it. The instructions below provide a description of the suggested quick test procedure.

1. Connect the signal cable to an available connector at a data logger.
2. Configure the sensor with the particular software.
3. Drop or spray water onto the sensor and make sure the reading changes.

Mounting to a Wooden Surface

To mount the sensor against a wooden surface, secure the sensor to the surface using wood screws (see Figure 83 on page 95).

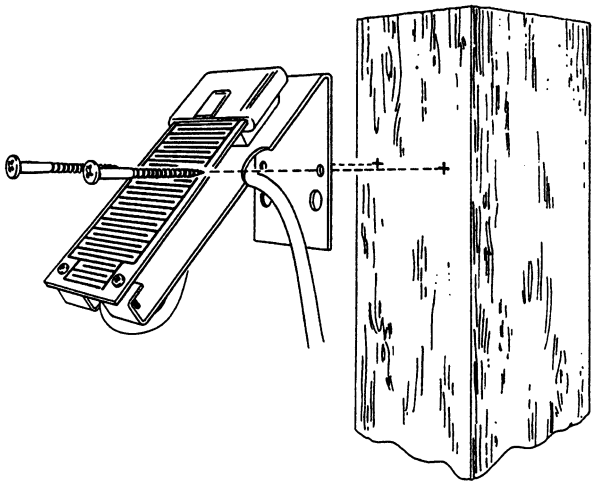


Figure 83 Mounting QLW101 to a Wooden Surface

Mounting to a Pole Mast

You can mount the sensor to a mast with an outside diameter between 25 and 31 mm. Secure the sensor to the pole mast using the U-bolt, flat washers, and hex nuts as shown in Figure 84 on page 96. Use a right size wrench or adjustable wrench to tighten the hex nuts.

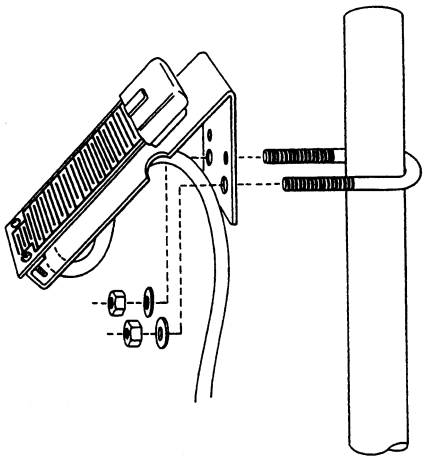


Figure 84 Mounting QLW101 to a Pole Mast

Mounting to a Sensor Support

For installation to the sensor support, use the provided hex bolts and lock washers. Tighten the hex nuts with a 6 mm Allen key. See Figure 85 on page 96.

Figure 85 QLW101 Installed to the Sensor Support

CHAPTER 5
OPERATION

This chapter provides the instructions for taking MAWS into use when all the equipment has been assembled and installed, as well as operating instructions for the MAWS Terminal software.

Operation Principle

MAWS works based on a so-called setup. Setup is a set of parameters that tells MAWS what to measure, log, calculate, and report. Measured data is stored in the daily log files that can be downloaded to a PC and viewed using the MAWS Terminal software. Alternatively, the data values can be viewed with the YourVIEW software, the optional handheld terminal, or Vaisala Digital Displays. The delivery/project-specific data reports can be configured to collect data from MAWS stations by data collection systems.

The Basic setup has been loaded in the MAWS program memory at the factory already. Therefore you simply need to connect the sensors, connect communication lines, and supply power to MAWS. Then your station will start operating, that is, making measurements, doing calculations and sending report(s). Normally, the provided example setups, for example, the Basic setup, need to be modified according to delivery-specific requirements.

On the MAWS CD-ROM, delivered to you with the system, you will find several setup examples. The delivered setups will suit typical needs, but you may want to make changes to them. For reconfiguring

the setup files or making totally new ones, refer to the MAWS Lizard Setup Software User's Guide.

Taking MAWS into Use

Setting Up Tripod

CAUTION	Be careful not to pinch the cables during installation.

1. Place the tripod in an upright position. Loosen the locking ring (number 2 in Figure 86 on page 98) with the hand screw (3), spread the legs and push the locking ring all the way down to the end of the bar (4). Lock by tightening the hand screw (3). The support bars should be horizontal.

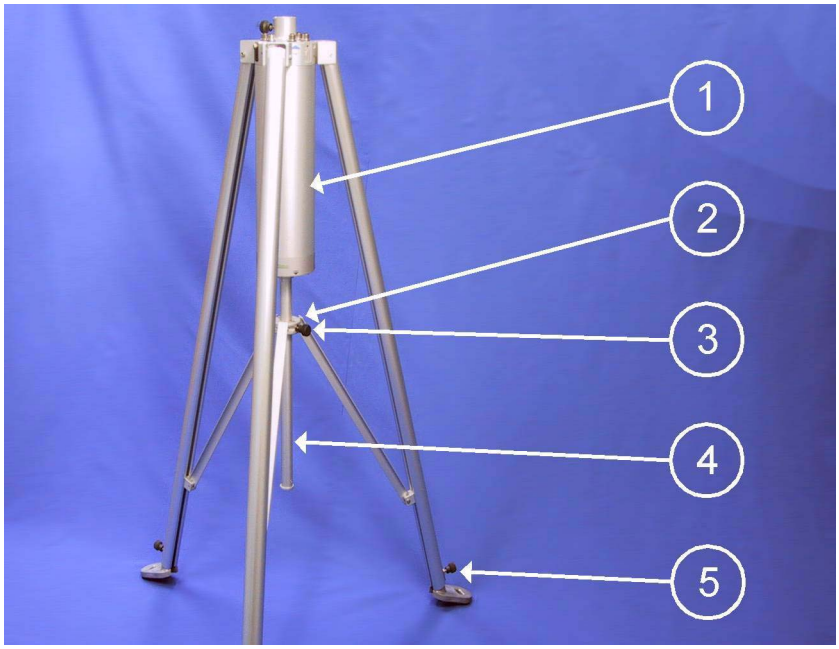


Figure 86 Mechanical Structure of Tripod

2. Point the solar panel leg towards south on the Northern Hemisphere (north on the Southern Hemisphere). Figure 87 on page 99 gives a suggestion of positioning the weather station on the Northern Hemisphere. The solar panel should face south, and the Air Temperature and Relative Humidity Sensor should be on the northern side of MAWS.

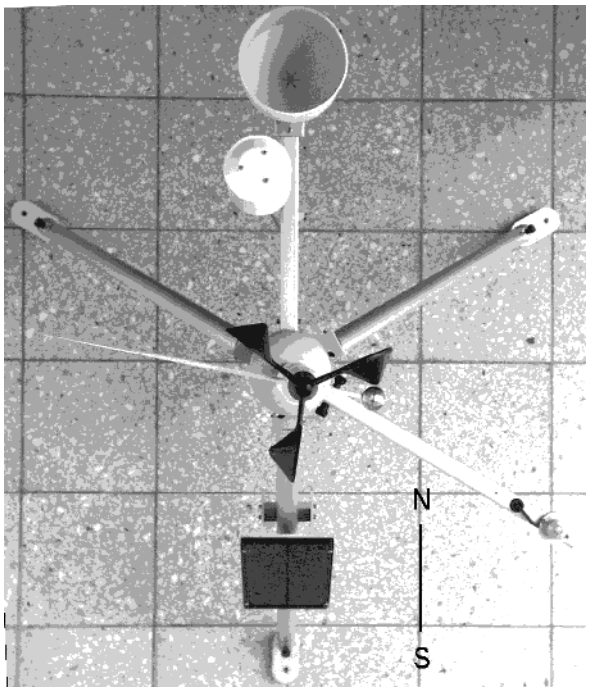


Figure 87 Aligning MAWS201 on the Northern Hemisphere

3. Check with the bubble level (number 1 in Figure 88 on page 99) that the station is leveled. The air bubble must be inside the circle. Adjust the legs to level the station.

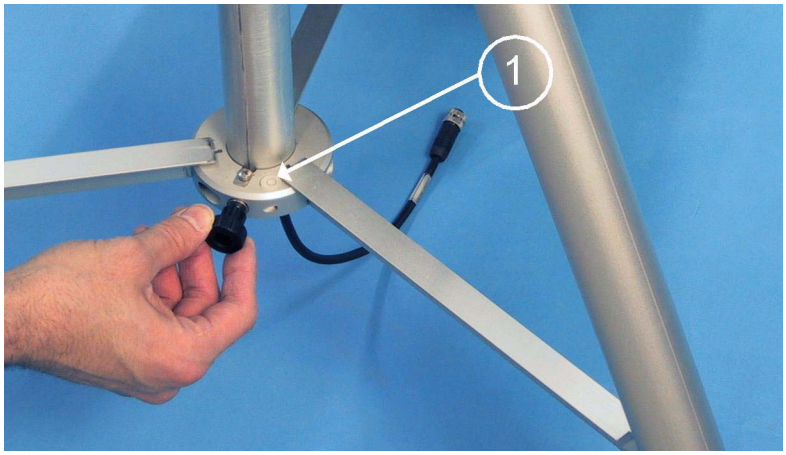


Figure 88 Leveling the Station

4. To adjust the length of the legs, loosen the hand screw (number 1 in Figure 89 on page 100) at the lower end of the leg. Extend the leg and lock by tightening the hand screw. After you have aligned the station, insert a peg through the hole (2) to the ground to secure

the leg. Use hammer to pound the ground pegs in. If the ground is too hard for the pegs, fill the ground peg bag with sand and/or stones. Attach the bag to the horizontal support bar with the straps.

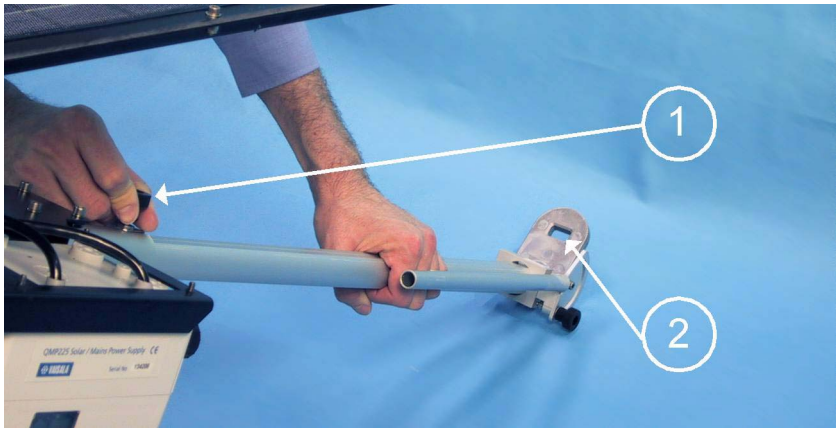


Figure 89 Adjusting the Leg

5. After you have leveled the station, secure the legs with ground pegs by inserting a peg through the hole as shown in Figure 90 on page 100.

Figure 90 Securing the Legs of the Tripod

6. For attachment of the wind sensor (number 1 in Figure 91 on page 101), the mounting piece has already been tightened with the small hex screw (5) on the top of the wind mast. Guide the wind sensor cable through the telescopic mast (if it is not already done) and connect the cable to the sensor. To connect the sensor to the wind mast, align the slot (3) on the bottom of the sensor with the metal

tab (4) on the mounting piece. Fix the sensor into its place by tightening the plastic collar (2).

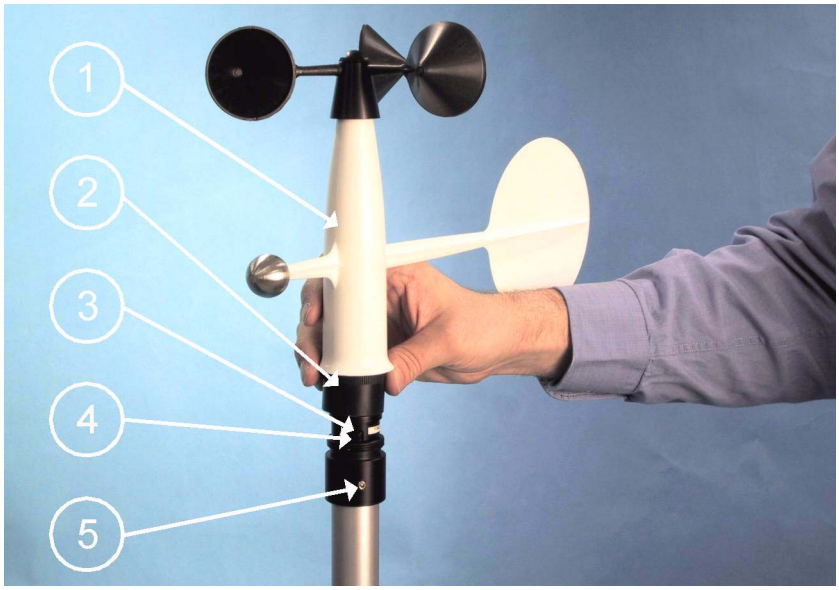


Figure 91 Wind Sensor Attachment

7. For attachment of the weather transmitter (number 1 in Figure 92 on page 102), guide the sensor cable through the wind mast (if it is not already done) and connect the cable to the sensor. To connect the sensor to the wind mast, remove the screw cover and insert weather transmitter to the mast. Align the transmitter in such a way that the arrow (2) points to north when the station is erected. Fix the sensor into its place by tightening the hex screw with an appropriate Allen key (3). Replace the screw cover.

Figure 92 Weather Transmitter Attachment

8. When using the optional telescopic mast, extend the mast. Open the latch (number 1 in Figure 93 on page 102) by lifting it up. Lift the inner mast (2) to the upper position while firmly holding the lower part (3) of the mast. Close the latch by pushing it down.

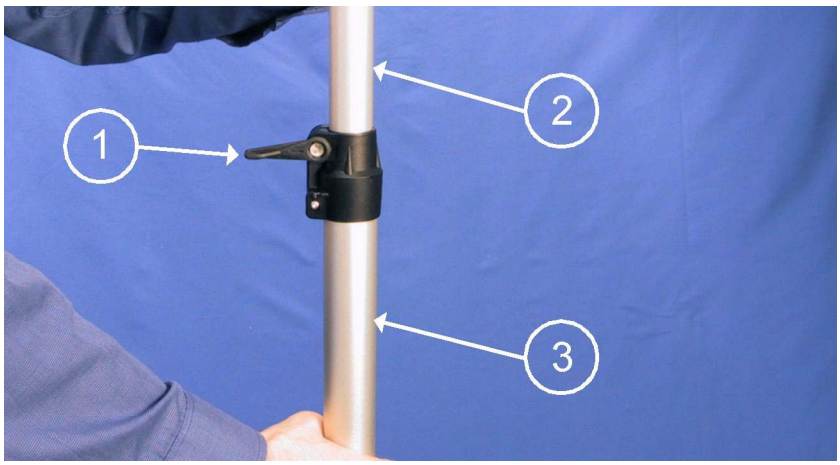


Figure 93 Extending the Optional Telescopic Mast

9. Attach the wind mast / telescopic mast to the upper base of the tripod. First lead the cable through the opening on the mast. Loosen the hand screw (number 3 in Figure 94 on page 103). Guide the mast into its place with the notch (1) facing the screw (2). Press the mast in place and tighten the hand screw (3).

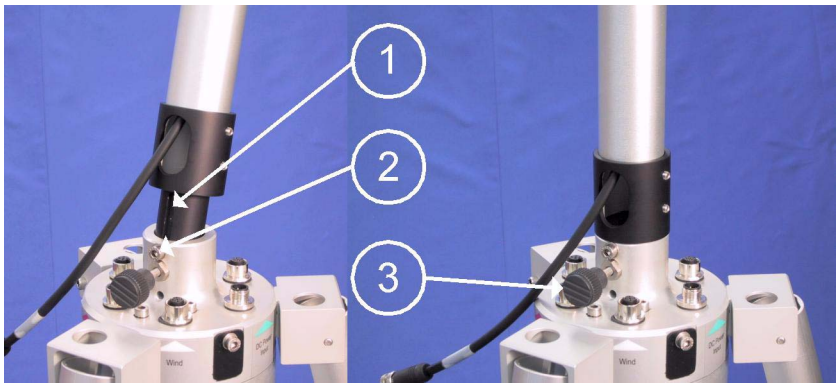


Figure 94 Attaching the Wind/Telescopic Mast

10. Lower the protection cover, see Figure 95 on page 103.

Figure 95 Protection Cover Lowered

11. Attach the sensor arm(s). Fit the cables into the opening below the sensor arm before tightening the hand screws (number 1 in Figure 96 on page 104).

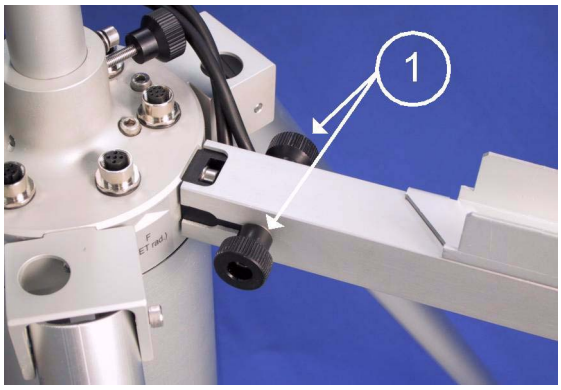


Figure 96 Sensor Arm Assembly

12. The optional Fuel Moisture Sensor is factory assembled to the sensor support bracket, and the sensor arm is factory assembled to the leg of the tripod. Release the hand screw (number 1 in Figure 97 on page 104) and turn the sensor arm to an angle of 45°. Push the sensor support bracket to the sensor arm and tighten the hand screw (number 2 in Figure 97 on page 104). Level the sensor horizontal 30 cm (1 ft.) above the surface by adjusting the sensor arm angle and the angle of the sensor.

CAUTION It is important to keep the wooden dowel part (number 3 in Figure 97 on page 104) of the sensor clean. Avoid touching the dowel with bare hands. Any contact with grease or oil will prevent the sensor from exchanging moisture and will make the calibration invalid.

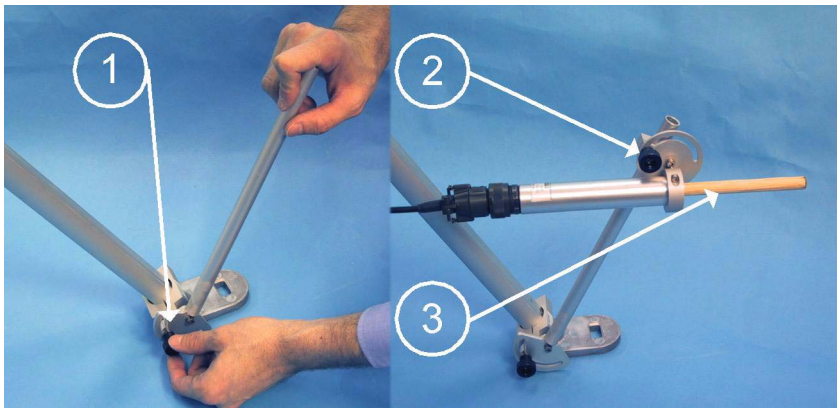


Figure 97 Fuel Moisture Sensor Attachment

13. Install the optional radio modem on the same arm as Rain Gauge and the radiation shield with the Air Temperature and Relative Humidity sensor. Press the back of the radio modem (number 3 in

Figure 98 on page 105) against the radio adapter between the two hex screws (2). Lower the radio modem down so that it is secured. Connect the antenna cable (1) and the data/power cable (4).

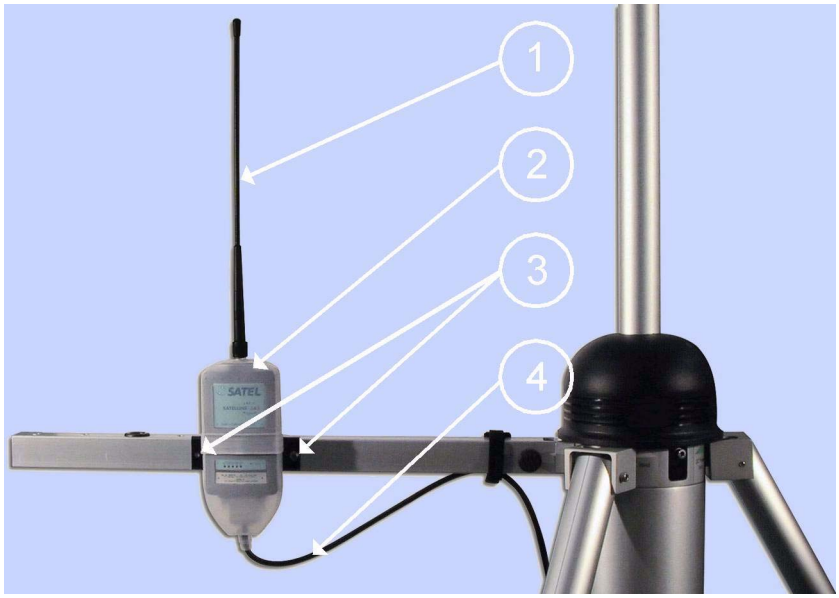


Figure 98 Installing Radio Modem

14. Install all the other sensors as instructed in Chapter 4, Installation, on page 57.
15. Connect all the cables.

Aligning Weather Transmitter

To help the alignment, there is an arrow and the text **North** on the bottom of the transmitter. Weather transmitter should be aligned in such a way that this arrow points to the north.

Wind direction can be referred either to true north, which uses the earth's geographic meridians, or to the magnetic north, which is read with a magnetic compass. The magnetic declination is the difference in degrees between the true north and magnetic north.

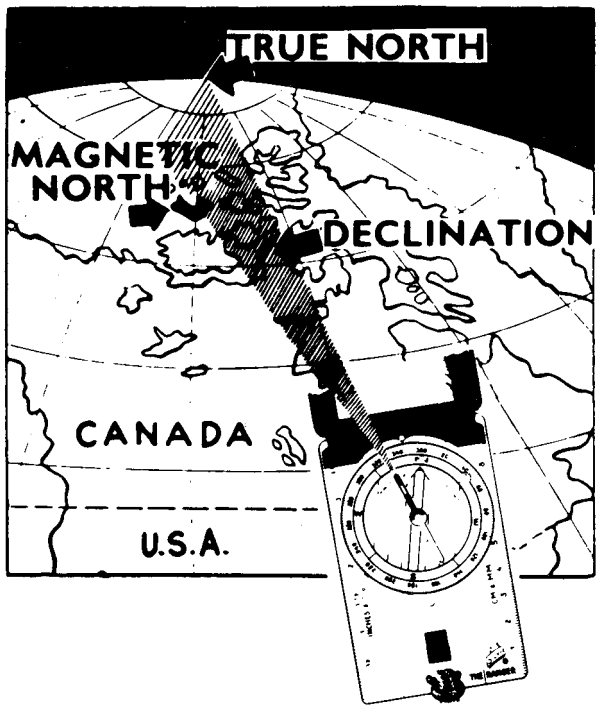


Figure 99 Sketch of Magnetic Declination

NOTE	The source for the magnetic declination must be current as the declination changes over time.

To align Weather Transmitter, proceed as follows:

1. If Weather Transmitter is already mounted, loosen the fixing screw on the bottom of the transmitter so that you can rotate the device.

Figure 100 Weather Transmitter Alignment

2. Use a compass to determine that the transducer heads of Weather Transmitter are exactly in line with the compass and that the arrow on the bottom (number 2 in Figure 100 on page 107) of Weather Transmitter (1) points to the north.
3. When the arrow (2) is exactly aligned to north tighten the fixing screw with an appropriate Allen key (3).

Aligning Wind Vane

Using winddircal0 Command

1. Turn the nose (number 1 in Figure 101 on page 108) of the vane to a known point of compass, for example, north.
2. Open MAWS Terminal.
3. Give command **open** to open the connection to MAWS. The **open** command is not echoed on the screen.
4. Give command **winddircal0** with the direction reading, for example, **winddircal0** *360*. This will set the current direction to the north, which equals 360 degrees.

Using Compass and Reference Point

With MAWS running, monitor the instant wind direction in the reports sent through the serial line.

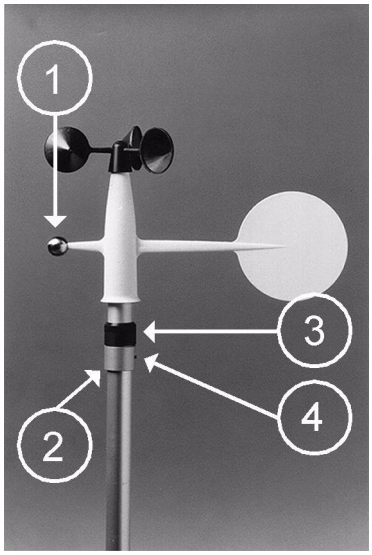


Figure 101 Aligning Wind Vane

1. The wind sensor cable must be connected both to the sensor and to the **Wind** connector.
2. The mounting piece (2) must be placed on top of the tube and the sensor must be attached to the mounting piece with the plastic collar (3).
3. Choose a known wind direction reference point on the horizon with the help of a compass.
4. Point the nose of the vane at the reference point.
5. Hold the vane in position and slowly rotate the mounting piece until the wind direction shows a proper value.
6. Secure the mounting piece to the mast by tightening the mounting screw (4).

Setting Up Solar Panel

NOTE	The rays of the sun should be perpendicular to the panel, which means sunlight should hit the panel at a 90° angle.

1. Face the panel south (true south, not magnetic) on the Northern Hemisphere and north on the Southern Hemisphere. The panel can be tilted towards the sun: the further you are from the equator the more vertical the panel.
2. To maximize the annual energy output, install the panel at an angle recommended in Table 8 on page 110. In some installations, it may be effective to adjust the tilt seasonally. At most latitudes, performance can be improved during summer by using an angle smaller than the table's recommendation. Conversely, a larger angle can improve winter performance.

   To set the correct tilting angle, slightly loosen the fixing bolts (1) and the adjustment bolts (2). Tilt the panel to the suitable angle, see Table 8 on page 110. Finally, tighten the bolts. Note the cable (3) when adjusting the angle.

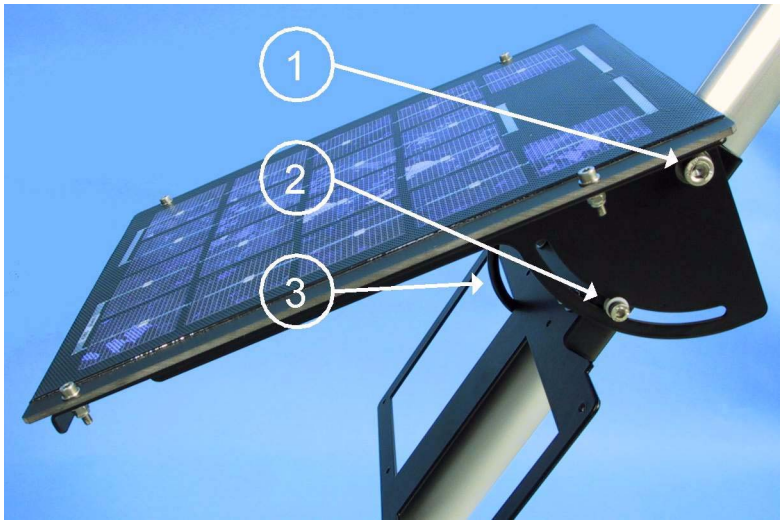


Figure 102 Solar Panel Angle Adjustment

Table 8 Recommended Tilt Angle for Solar Panel

Latitude of Site	Tilt Angle
0 ...10°	20°
10 ... 50°	Add 10° to local latitude
> 50°	60°

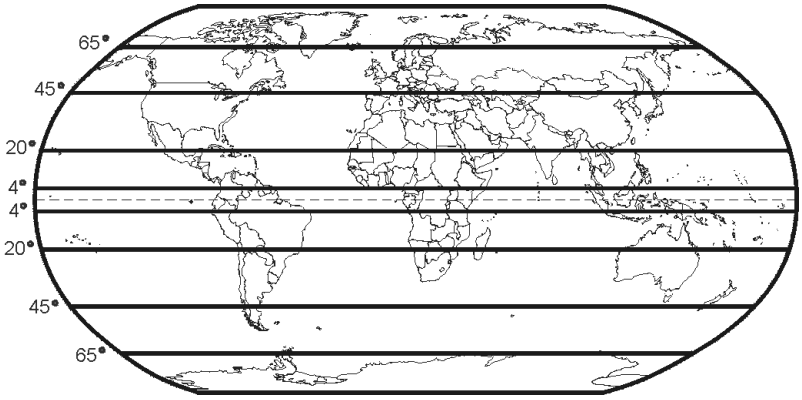


Figure 103 Map of Latitudes

Quick Start Instructions

The quick start instructions in Table 9 on page 111 are based on the following assumptions:

- You will use a default setup already loaded in MAWS.
- You have already assembled the MAWS system.

Table 9 Quick Start Instructions

Step	Action	Detailed Instruction
1.	Connect power to MAWS.	You can use the AC (mains) power supply or the solar panel.
2.	Establish terminal connection with MAWS.	See section Establishing Terminal Connection on page 112.
3.	Start the MAWS Terminal software.	See section Using MAWS Terminal Software on page 113.
4.	Set up station-dependent settings for MAWS.	See section Modifying Station Settings on page 125.
5.	Test the setup.	With the chosen setup loaded into MAWS (see section MAWS Setup File on page 135), check that you start receiving reports and that logging begins.

When taking MAWS into use for the first time or after connecting the battery, make sure that the station-dependent settings are correct, see section Using MAWS Terminal Software on page 113. For more information about the commands, see Table 20 on page 156.

NOTE Make sure that the battery is fully charged, and if not, charge the battery before taking MAWS into use.

Establishing Terminal Connection

To connect your computer to a MAWS serial port, proceed as follows:

1. Connect the provided terminal cable (QMZ101) to the **COM0** connector in the bottom plate of the tube and to an available COM port on your PC. See Figure 104 on page 112.

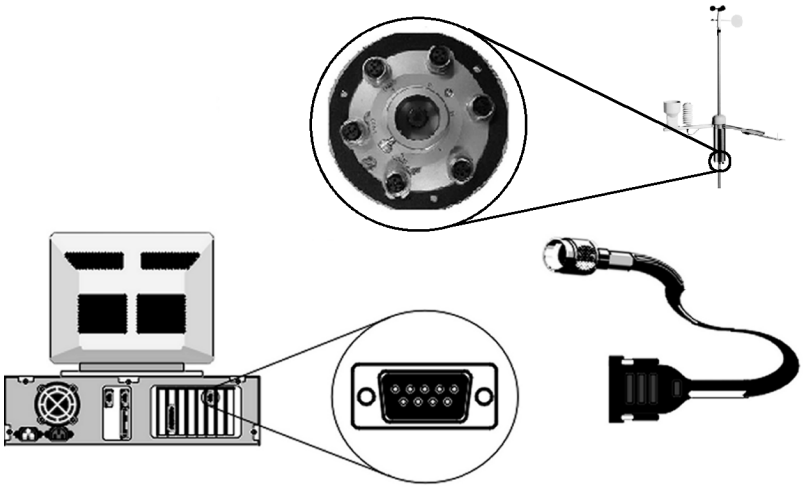


Figure 104 Connecting the Terminal Cable

2. Start the MAWS Terminal program on your PC, as instructed in section Using MAWS Terminal Software on page 113.
3. Set communication parameters: *9600, N, 8, 1*. For more information, see section Opening MAWS Service Connection on page 120.
4. Give the command **open** (if the connection is not already open). For more information, see section Giving Commands on page 122.

NOTE	The command **open** is not echoed on the screen.

Figure 105 on page 113 shows the pin order for the terminal connector.

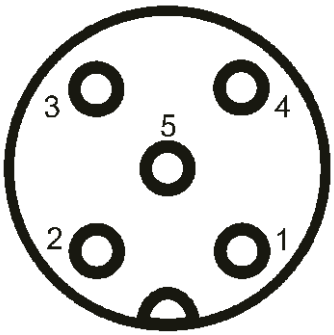


Figure 105 COM0 Pins for the Terminal Connector

The following numbers refer to Figure 105 on page 113.

1 = Not connected

2 = RxD

3 = GND

4 = TxD

5 = Not connected

Using MAWS Terminal Software

Selecting the Language

When you start MAWS Terminal for the first time, you are asked to select the language you would like to use. The **Select Language** window, presented in Figure 106 on page 114, appears. Select the desired language and click **OK**.

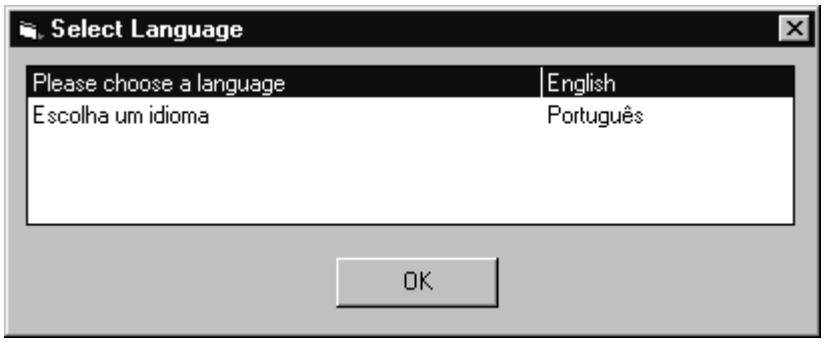


Figure 106 Select Language Window

The **Select Language** window appears only when MAWS Terminal is started for the first time. To change the language later, choose **Preferences** from the **Settings** menu, and then select the **Language** tab. In the **Language** tab, select the desired language from the **Available Languages** box and click **OK**.

MAWS Terminal Main Window

After selecting the language, or when you later start the MAWS Terminal software by clicking the **MAWS Terminal** icon on your desktop, the following window appears.

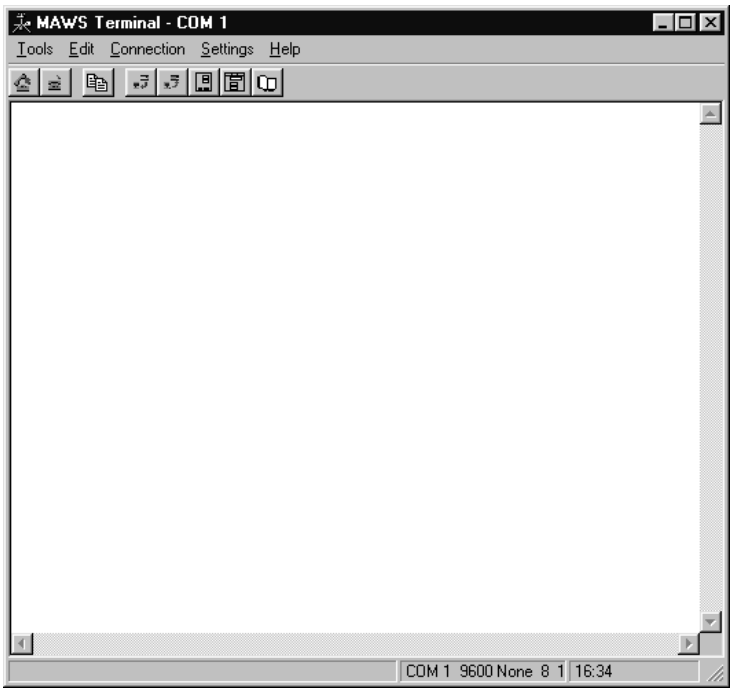


Figure 107 MAWS Terminal Main Window

When the service connection is closed, the messages and reports appear on the main window as shown in Figure 108 on page 116. Some values are shown as slashes, because they will be calculated from the measured values later.

NOTE The report type and appearance shown in Figure 108 on page 116 depend on your configuration.

When you have typed **open**, the service connection is open and you can communicate with MAWS with the commands described in Table 20 on page 156.

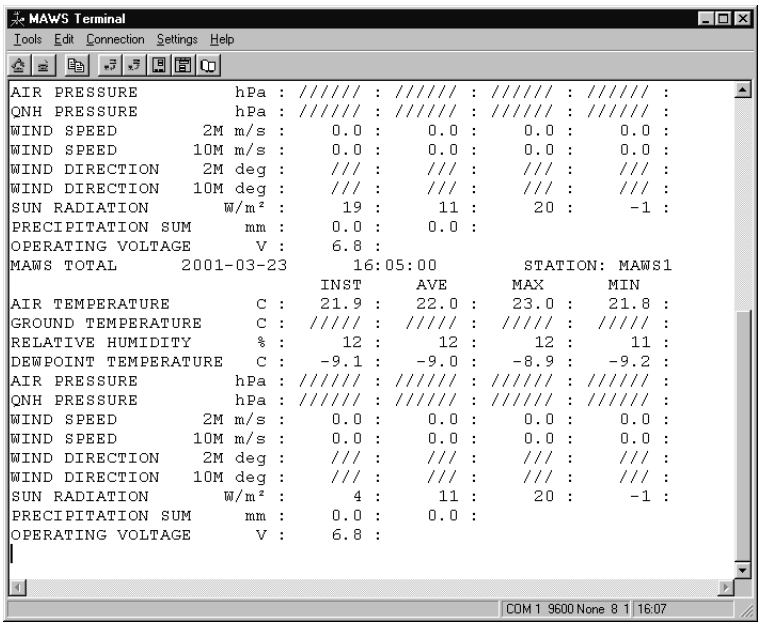


Figure 108 MAWS Terminal Showing Report

On the top of the main window, there is the MAWS Terminal toolbar. The toolbar is the quickest way to select functions.

Table 10 Description of the Toolbar

Icon	Function	Description
	Dial	Establish a connection to the MAWS station you have selected or to the modem you use for connecting to MAWS.
	Hangup	Close the connection to MAWS.
	Copy	Copy the selected text to Windows Clipboard.
	Download Log Files	Select the data log files you want to download and start downloading.
	Upload Configuration File	Select the new configuration file you want to upload and start uploading.
	Set Station Settings	Define default settings for the MAWS station.
	Preferences	Define default settings for the download.
	Address Book	Open the address book for browsing communication settings.

You can exit MAWS Terminal by choosing the **Exit** option from the **Tools** menu.

Defining MAWS Terminal Settings

When you start the software for the first time, you need to define the settings to be used during download. Use the **Settings** menu options for this purpose.

Preferences Window

When you choose the **Preferences** option from the **Settings** menu, the **Preferences** window appears with the **Directories** tab.

Table 11 Description of Preference Window Tabs

Tab	Description
Directories	On the **Directories** tab, you can define the directories you want to use for downloading and storing files, see Figure 109 on page 118. If you do not define a directory, the program stores all file types in C:\MAWS_LOG.
Download	On the **Download** tab, you can define the operations that the program runs automatically whenever you download data log files from MAWS, see Figure 110 on page 119.
Communications	On the **Communications** tab, you can define the communication port and related parameters. The default values are *COM1, 9600, None, 8, None, 1,* and buffer size *4 kB*. Normally, you do not need to change the communication settings.
Dialer	If your system connects to MAWS via a modem, you can select how many times the modem tries to connect to MAWS if the first attempt is unsuccessful.
CSV formatting	On the **CSV formatting** tab, you can define whether the date and time information is stored in separate columns or as one character string, e.g., `Wed Jan 02 02:03:55 1980`.
MAWS Station settings	When you update the MAWS configuration file and the system is reset, MAWS spends a defined period checking the configuration. During this time, it does not respond to commands you send to the maintenance line. On this tab, you can define the length of the delay period.

Table 11 Description of Preference Window Tabs (Continued)

Tab	Description
Show Dialogs	On the **Show Dialogs** tab, you can select which dialogs you want displayed during the download process.
Language	On the **Language** tab, you can select the language that is used in the interface.

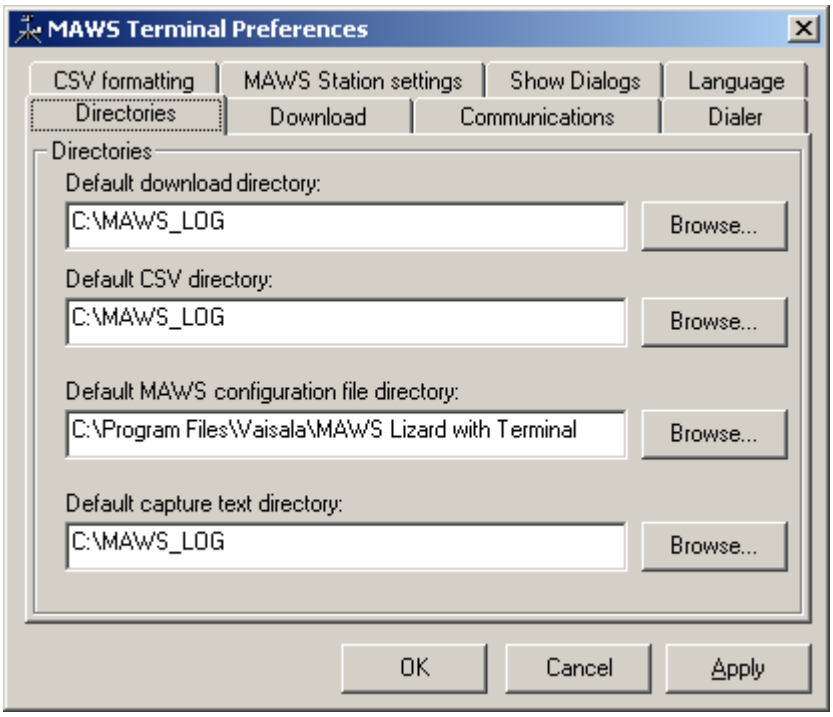


Figure 109 Directories Tab in Preferences Window

When you select **Convert file to CSV format** on the **Download** tab, you may also enable merging of the downloaded files by selecting **Merge CSV files of same log group**.

The merge feature can also be selected case by case in either of the two windows:

a. When downloading the files from MAWS with the MAWS Terminal software, you may select **Merge CSV files belonging to same log group** in the **Set Download Preferences** window.

b. When converting the log files, you may select **Merge files** in the **Convert Log Files** window.

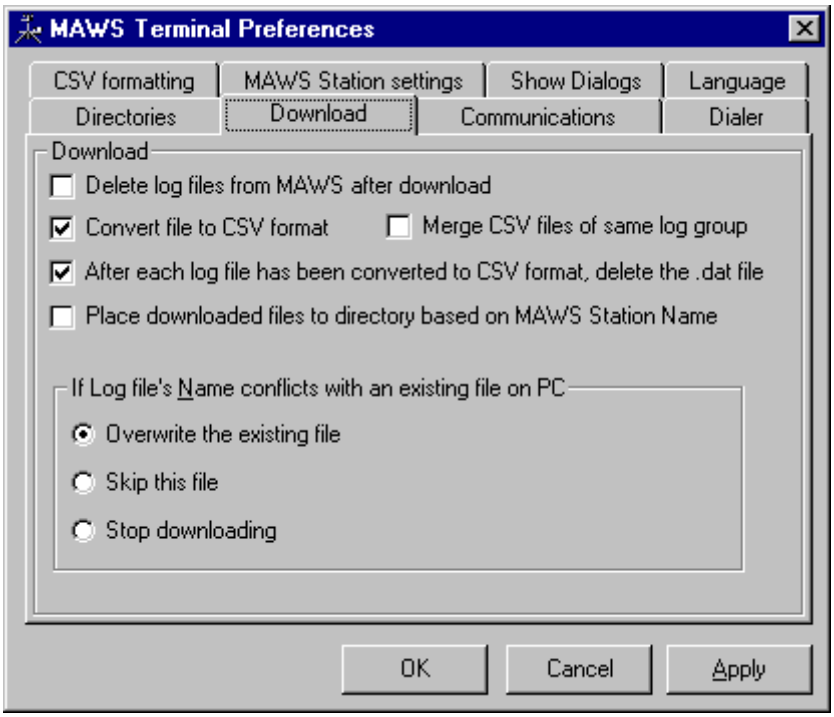


Figure 110 Download Tab in Preferences Window

Address Book Window

When you choose the **Address Book** option from the **Settings** menu, the window shown in Figure 111 on page 119 appears.

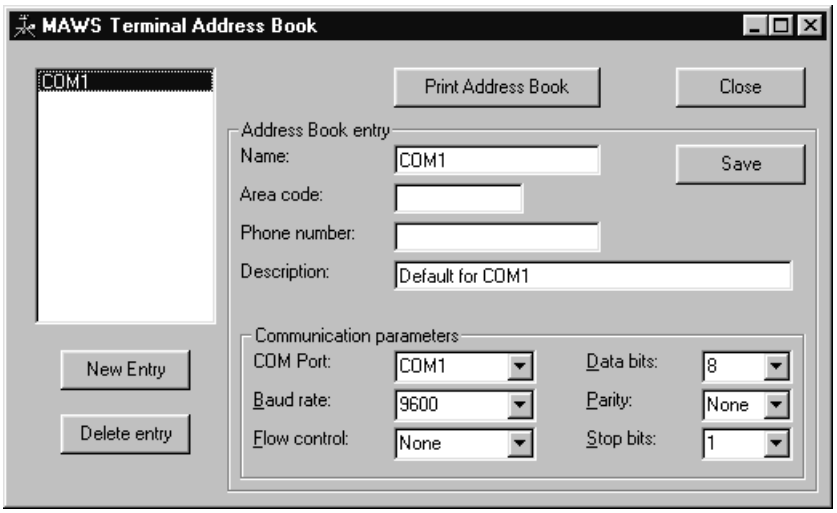


Figure 111 Address Book Window

In the **Address Book** window, you can define MAWS communication details. You can also define parameters for both directly connected stations and for stations that establish the connection via modem. You can add new entries and delete old ones.

Opening MAWS Service Connection

Before you can download files or upload the configuration file, you need to open the service connection to MAWS.

MAWS Terminal supports any number of serial ports available in the computer. The software reads from the registry of the Windows® operating system which serial ports are installed. The **Select Address Book entry** list shows the serial ports that are available for selection. For an example, see Figure 112 on page 121. The user may select any applicable COM port from the list.

This feature also enables the use of USB to RS-232 converter cables that are usually installed above any other COM ports installed to a computer. The COM port number of a converter cable depends on the system configuration. For example, in a desktop computer with only two physical COM ports (COM1 and COM2), a converter cable is installed as COM3.

When reassigning the COM ports after installation, for example, when changing COM5 to COM4 afterwards, you need to recreate the address book entry for the modified COM port manually.

To establish a connection to MAWS, choose **Dial** from the **Connection** menu. You can also click the **Dial** icon. The **Select Address Book entry to dial** window appears, see Figure 112 on page 121.

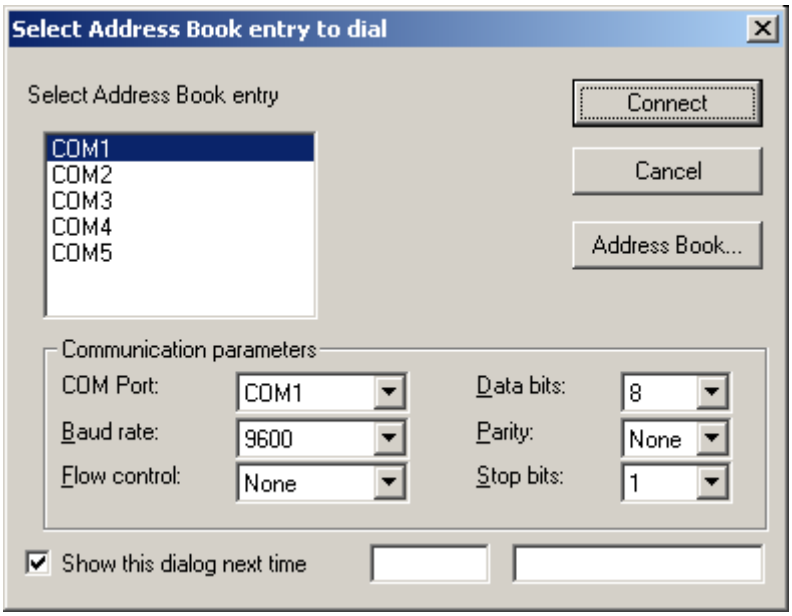


Figure 112 Select Address Book Entry to Dial Window

In the **Select Address Book entry to dial** window, select the port to which MAWS is connected and click **Connect**.

NOTE Before connecting, the **Password Entry** window opens, if you have set the user level in your MAWS. For more information on setting the user levels, see section Managing User Levels on page 123.

When the connection is opened, you will see the following text on your screen.

```
Service connection opened
/>
```

NOTE The next time you are opening a service connection, the address book window is displayed. The program does not automatically connect you to the port you previously selected. If you do not want the address book window to be displayed every time you connect to MAWS, you can clear the **Show address book list before connecting** check box from the **Settings - Preferences - Show Dialogs**.

Giving Commands

When you have established the connection, you can use the commands described in Table 20 on page 156 to communicate with MAWS. Commands are text strings sent from the PC or terminal to MAWS.

To open the connection, give the **open** command. To close the terminal connection, give the **close command**. Logging is not affected unless it is stopped using the **logstop** command. In the closed mode, the serial line will be available for report sending.

NOTE Both **open** and **close** commands have to be typed exactly correct before they can be executed. This means, you can not use the BACKSPACE key to correct your typing. Simply retype the command and press ENTER to give the command again.

Most of the commands can be used both for setting a value for a parameter and viewing the set value of a parameter.

Type **help** to get a list of the available commands. Each command must be entered using the correct syntax. You do not have to memorize complex commands since you can view a help text that shows the correct syntax at any time. Simply type **help** and the command name.

Table 12 Interpreting Help Texts (the Correct Syntax)

Generic Representation	Example		Note
Use the parameter name.	**warnings** [*clear*]	To see the warnings, type: **warnings**	Parameters shown in [ ] can be left out.
		To remove warnings, type: **warnings** *clear*	
Replace parameter symbols with values.	**time** [*HH MM SS*] [*YY MM DD*]	To see current time, type: **time**	
		To set new time, type e.g.: **time** *15 45 00*	
		To set new time and date, e.g.: **time** *15 45 00 03 06 18*	
	loggo <*group_id*>		Parameters shown in < > cannot be left out.

NOTE	Commands have to be typed in the same case as indicated in the help texts, usually in the lower case.

The command name and the following parameters are always separated by a space. Pressing ENTER (return) will execute the command so that MAWS reads the typed command.

You can use BACKSPACE to delete the last typed character.

Use CTRL+P (hold down the CTRL key and press P) to repeat the previously typed command. Use CTRL+P (Previous) and CTRL+N (Next) to scroll through the list of previously typed commands. When you find the command you would like to repeat, simply press ENTER. File commands (**dir**, **del**, **copy**, **move**, **verify**) can be aborted with CTRL+C.

Closing MAWS Service Connection

If your MAWS connection works via a modem, you must remember to close the line after you finish working with MAWS. To close the connection, choose **Hangup** from the **Connection** menu.

If your MAWS connection is direct, it is recommended that you close the service connection by entering the **close** command. The program closes the service connection automatically after 5 minutes.

Managing User Levels

You can use the **userlevel** command to protect the system from unauthorized use. The system provides three password-protected access levels to the shell commands as well as to the visibility of system data. By default, the user levels are not in use.

CAUTION	Improper use of the **userlevel** command may lead to malfunction of the logger.

You can manage user levels by the **userlevel** command when the service connection is open. The command has the following syntax:

userlevel [*level <set/clear>*]

where

level	=	1, 3, or 5
set	=	Sets the password for a level
clear	=	Clears the password from the level

To check the current setting, give the command alone, without parameters. When you want to change the level, give the command with parameters. When you change the level to a higher one, a password is required. When you change the level to a lower one, a password is not required.

To change the password for the level, give the command with the appropriate level and the set parameter. For this operation, the effective user level has to be the highest, that is, 5. The change of the password becomes effective immediately.

To remove the password for the level, give the command with the appropriate level and the *clear* parameter. For this operation, the effective user level has to be the highest, that is 5. The change of the password becomes effective immediately.

CAUTION Setting a new or clearing an existing user level is effective only after resetting MAWS. When setting a new level or clearing an existing one, be sure to reset the system before closing the service connection. Otherwise, you may not be able to access the system without the cold reset.

To check the allowed commands at a specific level, give the **help** command. Table 13 on page 125 lists the accessible commands in the different user levels. Level 1 provides access to the minimum set of commands and visibility of system parameters. Level 3 provides access to all commands needed for normal administration and commissioning.

Level 5 provides access to all commands. For the command reference, see Table 20 on page 156.

Table 13 Accessible Commands in Different User Levels

User Level	Commands
Userlevel 1	cd, copy, dir, errors, help, logshow, logshownext, logshowprev, logstatus, rep, warnings, and zs
Userlevel 3	EXTFS, LOGFS, altitude, battery, cd, chmod, copy, del, dir, errors, help, logdel, loggo, logshow, logshownext, logshowprev, logstatus, logstop, md, move, pslevel, rd, rep, reset, serial, sname, spclear, spset, time, timezone, verify, warnings, winddircal0, zr, and zs
Userlevel 5	All the userlevel 3 commands and the userlevel administrator rights.

Modifying Station Settings

In MAWS Terminal, you can modify the station settings. When you select the **Set Stations Settings** option from the **Tools** menu, the **MAWS Station Settings** window appears, see Figure 113 on page 125. Under **MAWS common parameters**, the separate fields are used for setting the common parameters to a station. Table 14 on page 126 lists the items, which are changeable.

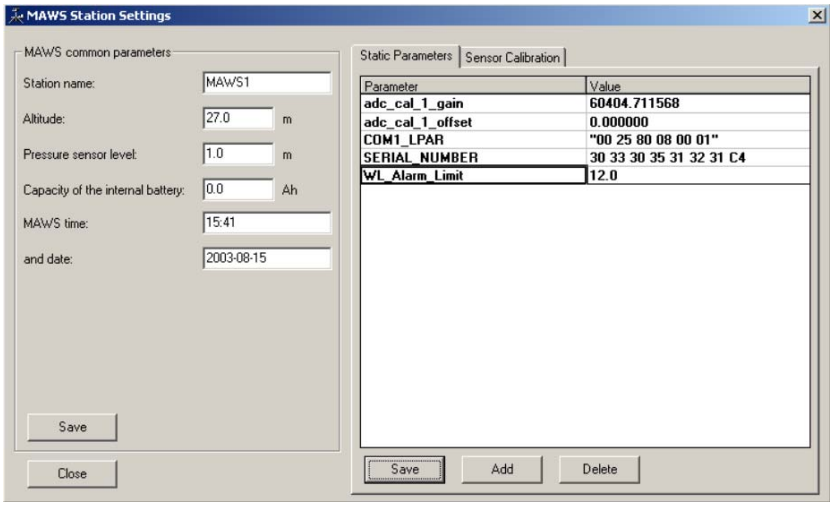


Figure 113 MAWS Station Settings Window

Table 14 Description of MAWS Station Settings Window

Item	Description
Station name	You can define a name for your station.
Altitude	Enter the altitude of the MAWS station from sea level.
Pressure sensor level	The height of the pressure sensor on the MAWS mast.
Capacity of the internal battery	Enter the capacity of the MAWS internal battery QMB101. Note that this value is set to zero when high capacity back-up batteries are included in the delivery, which normally is the case with the HydroMet systems.
MAWS time and date	After you change the MAWS battery, you need to set the system clock. Type the correct time (HH:MM) and date (YY-MM-DD) in the appropriate fields and click **Save**.
Static Parameters tab	The list of the static parameters (depends on your configuration).
Sensor Calibration tab	The list of the connected sensors and the calibration values (depends on your configuration).
Manual Entry tab	The list of the manual sensors and their values is visible only when manual sensors are included in the setup (depends on your configuration).

Setting Static Parameters

To be able to use static parameters in MAWS, you must first create them in MAWS Lizard and then either use the default values given in MAWS Lizard or change the values in MAWS Terminal.

The MAWS Lizard Setup Software provides an interface for creating setup-specific static parameters to be used, for example, as station-dependent parameters or as calculation factors. This interface is in the **Setup Management** view and it is only available on the advanced user level.

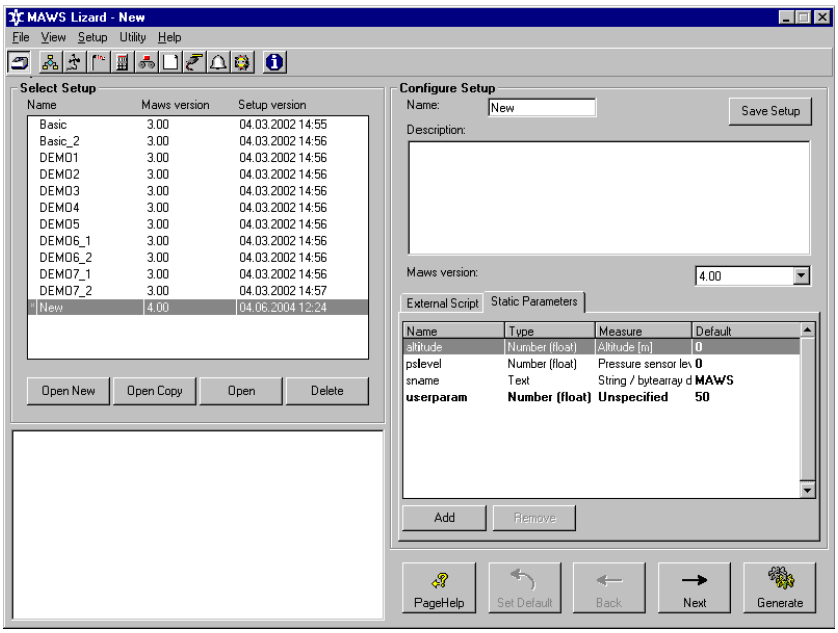


Figure 114 Setup Management View: Static Parameters Tab

The list under the **Static Parameters** tab shows all the static parameters, including the preset ones. Refer to Figure 114 on page 127. The user editable entries are listed in **bold**. The **Default** column shows the default value for each parameter.

NOTE The default value is written to the logger memory only when the static parameter does not have an existing value. For example, if the **sname** parameter already has the value *MAWS1* and a new setup is generated with **sname** = *MAWS2*, the existing sname value (*MAWS1*) is preserved.

To create a new static parameter, proceed as follows:

1. In the **Static Parameters** tab, click **Add**.
2. Give a name for the parameter. The name may consist of characters A...Z, a...z, 0...9, and _. No spaces are allowed.
3. Select a type for the parameter. The possible options, **Number (float)**, **Number (int)**, or **Text**, will appear by double-clicking the bold text in the **Type** column. Selecting the type will determine how the parameter is used. A text parameter, for example, cannot be used as calculation input.

4. If the parameter is numeric, it is recommended that you also select a measure unit for it. If the parameter is used as a station-specific calculation parameter, you should provide it with a correct unit, because otherwise the calculation configuration may not allow you to use the parameter as input. If there is no suitable unit available, select **unspecified**. This makes the parameter applicable for all use.
5. Enter a default value for the parameter.

NOTE	All parameters are automatically created to the logger when the setup is uploaded.

The value of a static parameter, which can be a default value given in MAWS Lizard, can be changed in the **Station Settings** window of MAWS Terminal. The **Static Parameters** tab shows all parameters and their values, also those that have been set directly with the MAWS Terminal software, see Figure 115 on page 128. To change the value of a static parameter, proceed as follows:

1. Start MAWS Terminal and select **Station Settings** from the **Tools** menu.
2. In the **Static Parameters** tab of the **Station Settings** window, double-click the corresponding **Value** cell. Enter the new parameter value.

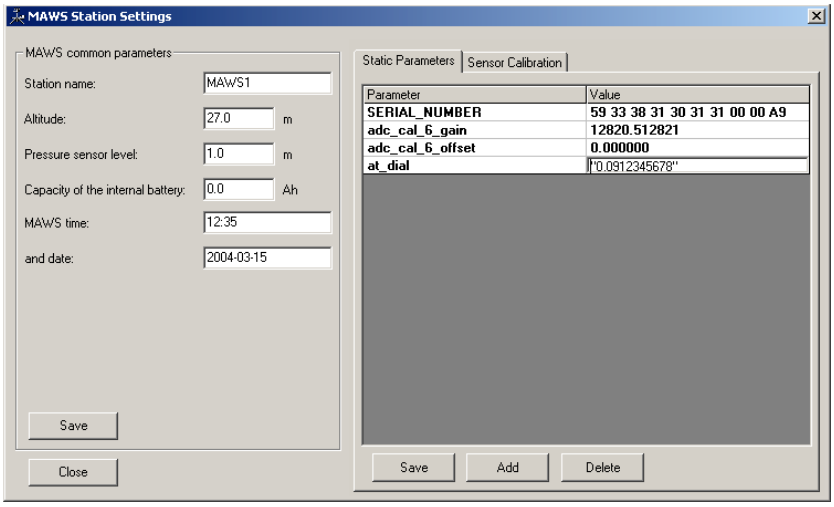


Figure 115 MAWS Station Settings Window

3. Click **Save** to store the new parameter value to MAWS. You can also change multiple values and save them all at once.

Calibrating Sensors

For calibrating the sensors with MAWS Terminal, the **Sensor Calibration** tab is available in the **MAWS Stations Settings** window, see Figure 116 on page 129. The list of the MAWS sensors is displayed in the tab.

NOTE You must load an appropriate setup to MAWS before you are able to use the **Sensor Calibration** tab.

NOTE The **Sensor Calibration** tab is not visible for setups made with MAWS software versions prior to 3.06. With old setups, **MAWS common parameters** frame only shows the calibration values for the wind direction and solar radiation sensors, and other sensors need to be calibrated through the terminal connection with the appropriate calibration commands.

CAUTION When you upgrade a previous MAWS version to 3.06 or above, the following sensors will not operate correctly in the **Sensor Calibration** tab until they are removed from the setup and then re-created: CM6B, CM11, QMS101, QMS102, and QMN101.

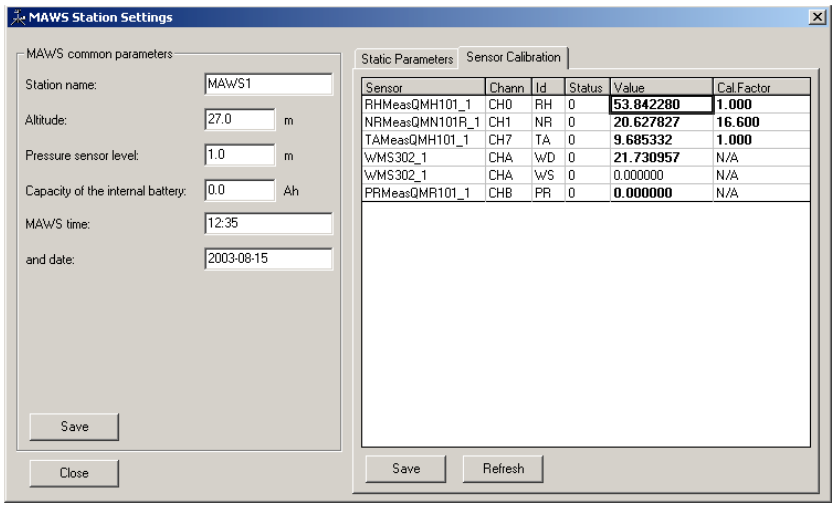


Figure 116 MAWS Station Settings Window: Sensor Calibration Tab

The list in the **Sensor Calibration** tab does not refresh automatically. To read the latest measurement values, click the **Refresh** button. You may enter new values to the cells in bold font. You can not change the cells with the value N/A. Table 15 on page 130 describes the columns in the **Sensor Calibration** tab.

NOTE

When **Value** is expressed as N/A, it indicates that the calibration factor has been altered but not saved, the sensor has not been measured or its measurement channel has failed, or the sensor is disabled. Further information about the possible reason can be obtained by comparing the value in the **Status** column against the values listed in Table 16 on page 132.

Table 15 Columns in the Sensor Calibration Tab

Column	Description	Input
Sensor	The sensor name as defined in the setup.	n/a
Channel	The measurement channel of the sensor.	n/a
ID	The measurement identifier	n/a
Status	The sensor status	n/a
Value	The last measured sensor reading shown in physical units.	Overwrites the sensor reading with the entered value, that is, changes the offset of the measurement.
Cal.Factor	The measurement gain for the sensors, except for the radiation sensors (QMN10x and QMS10x) the sensitivity value.	Overwrites the old gain value with the new one. For radiation sensors (QMN10x and QMS10x), changes the sensitivity value.

Calibration is done by entering the sensor-specific **Value** and/or **Cal. Factor** parameters.

- The **Value** parameter affects the offset of the measurement. Entering a new value changes the sensor reading to the given value, and the new offset for the measurement is set.
- The **Cal. Factor** parameter has sensor dependent use. It affects the gain of the measurement or the sensitivity of the radiation sensors. To calibrate radiation sensors QMN10x and QMS10x with MAWS, enter the sensor dependent sensitivity factor [V/Wm-2], which is given in the type sticker or calibration sheet of the

particular sensor. To calibrate other listed sensors, enter the gain of the measurement, that is, the slope of the conversion curve.

NOTE You can do either offset or gain calibration at a time. When you enter a new value in the **Value** or **Cal. Factor** field, the other parameter will be expressed as `N/A` until you save your changes. Note also that entering a new value in the **Value** field, for example when performing offset calibration, will reset the gain to 1.000.

After you have changed the value(s), click the **Save** button in the tab to write the new values to MAWS.

NOTE New sensor calibration values are taken into use after resetting MAWS, for example, with the **RESET** command.

Sensor Status List

Table 16 Sensor Status List

Value	Meaning	Notes
0	The sensor is working properly (OK).	
1	Not measured yet	
2	Interface is not initialized.	1
3	Communication time out has occurred.	1
4	Unknown data is received.	1
5	Communication is functioning, but the sensor reports errors. Use sensor's own service interface to find out cause.	1
6	Sensor communication is paused because service connection is opened through MAWS.	1
7	Message sequence numbers are overlapping in the Autotrac satellite transceiver interface.	1
8 ... 19	Not available	
20	Excitation failure is caused by overload in the excitation output.	2
21	The input voltage is out of range or the A/D conversion has failed due to an internal error.	2
22	Sensor is disconnected or the connection cables are broken.	2
23	Sensor output exceeds the min/max limits defined in the **Measurements** view.	2
24	Change in sensor output has exceeded the maximum step defined in the **Measurements** view.	2
25	An internal configuration error has occurred.	2
26	Error in reference measurement, which is usually caused by damaged sensor/logger or electrical interference.	2
27	Internal voltage error occurred or the logger is damaged.	2
28	PMT16 calibration data error.	2
29	Data is invalid for unspecified reason.	2
30	The measurement or the sensor has been manually disabled.	
99	Sensor status is not supported.	

1. Value is available only for sensors with a serial interface.
2. Value is available only for sensors with a conventional, that is, analog or counter/frequency interface.

Entering Values Manually

Before you can manually enter data to MAWS using MAWS Terminal, you must create and configure manual sensor(s) in MAWS Lizard.

Creating Manual Sensor in MAWS Lizard

In the **Equipment** view, select *ManualSensor* and click **Add**. *ManualSensor* is automatically connected to the **Console** connector, see Figure 117 on page 133.

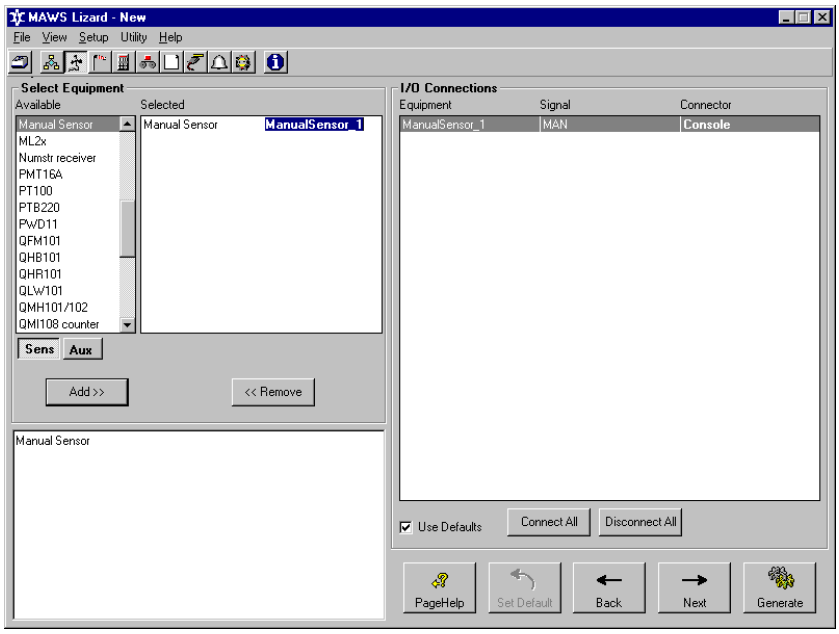


Figure 117 Creating Manual Sensor in MAWS Lizard

Configure the manual sensor to use the correct **Datatype**, **Validity period**, and so on, see Figure 118 on page 134.

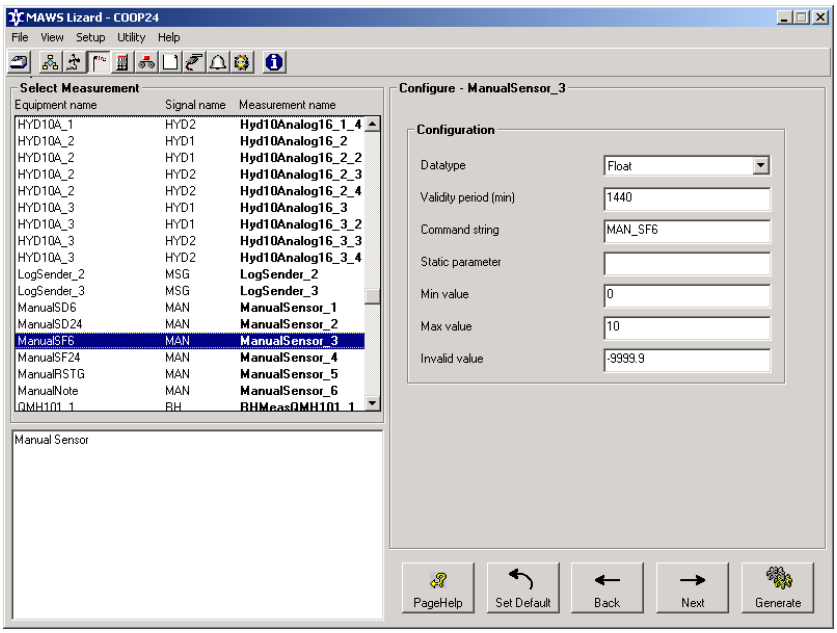


Figure 118 Configuring Manual Sensor in MAWS Lizard

Manual Entry in MAWS Terminal

In MAWS Terminal, the **Manual Entry** tab lists all the manual sensors, see Figure 119 on page 135. The **T** column shows the data type and the **St** column the status.

To enter values for manual sensors, follow the instructions below:

1. To access the **Manual Entry** in MAWS Terminal, select **Station settings** in the **Tools** menu and the **Manual Entry** tab.
2. In the **Manual Entry** tab, select a manual sensor from the list and double-click the appropriate cell in the **Value** column to enter the correct value for the manual sensor.
3. Click **Save** to save the changed value to MAWS.

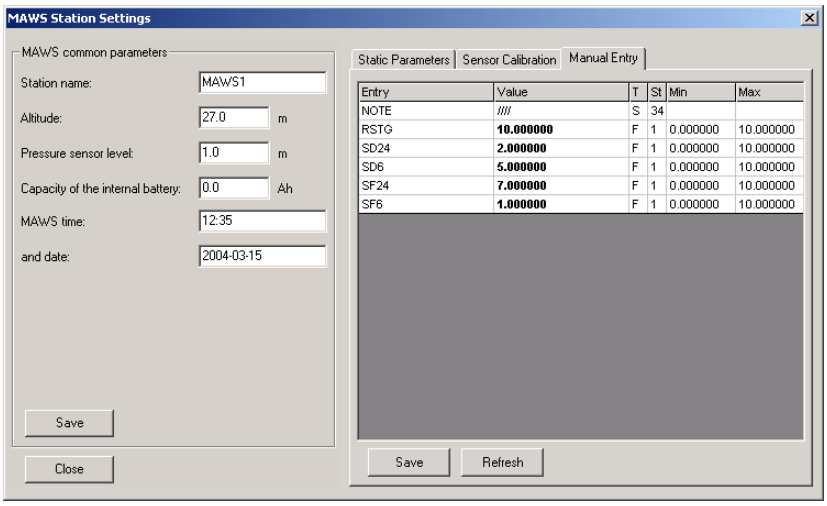


Figure 119 Manual Entry Tab

MAWS Setup File

When you start using MAWS for the first time, you need to upload a setup file from your PC to the MAWS station.

This setup file includes all details required for the system to function properly: which sensors the system contains, which settings they use, to which MAWS channels they are connected, and how often they calculate weather parameters. The setup file also defines the frequency at which MAWS logs data in a file and the number of days for which data log files are kept in MAWS memory.

For archiving the setup files, save them as .dtg files to a folder in a reliable backup device. For more information, refer to MAWS Lizard Setup Software User's Guide.

Selecting Setup File

MAWS Lizard Setup Software comes with some ready-made setup files from which you can choose the one to be used. You can select the file that best suits your system. The main difference between the setups is that with some of them, the system measures weather data more frequently, logs more variables by having more sensors, and produces more reports than with others.

You can modify one of the setup files with MAWS Lizard Setup Software to produce exactly the setup you want. However, this requires a thorough understanding of the system. For more information, refer to MAWS Lizard Setup Software User's Guide.

CAUTION	If you create a setup of your own by modifying the ready-made files, store the new file under a different name. This way, you can go back to the original setup in case the new one does not work.

CAUTION	Also notice that the settings you define in the setup file must match the settings you make in the **Preferences** window and the **MAWS Stations Settings** window.

Uploading Setup File

CAUTION	When you upload a new setup, the system erases all data log files from MAWS. Make sure you download the files you want to save before uploading the new setup. For more information on downloading data log files, see section Selecting Files for Downloading on page 143.

You need to upload the MAWS setup file in two occasions:

- When you start using MAWS for the first time.
- When your system has been updated, for example, when new sensors have been added.

After a system update, the setup file needs to be updated to match the changes. Normally, you need to modify the setup file yourself with the MAWS Lizard Setup Software. After you have finalized with MAWS Lizard, you have to open the MAWS Terminal in order to be able to upload the setup file as follows:

1. On the **Tools** menu, select **Upload Configuration**.
2. The **Select the configuration file for upload** window appears, see Figure 120 on page 137. Select the appropriate setup file and click **Open**.

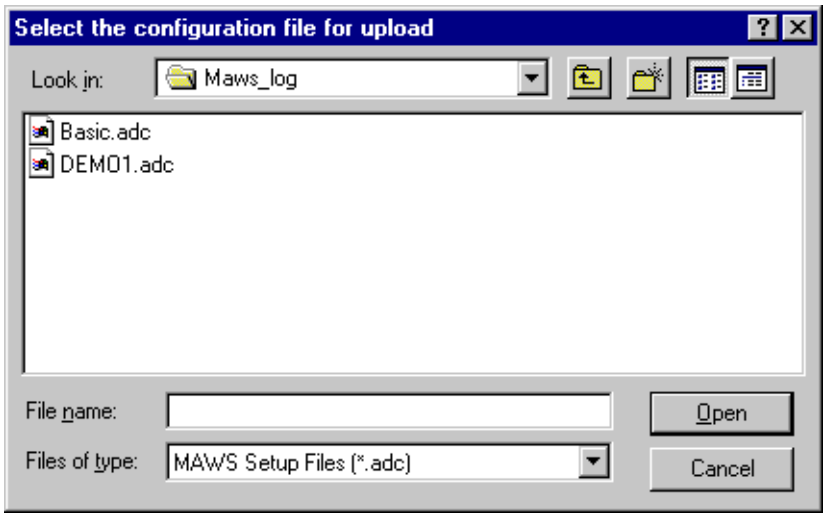


Figure 120 Selecting an Upload Configuration File

3. When the file has been transferred, MAWS starts executing the new setup according to the settings in the setup file.

Data Logging

Logging means storing of the measured and calculated data in the MAWS internal memory, that is, to a 2 MB Flash chip with a data storage capacity of 1.6 MB. Additionally, you may use an external memory card. For more information, see section Using External Memory Card on page 153. From the internal and external memory, logged data can be retrieved later, for example, via a serial line.

Logged data is stored in the daily files, for example, L2010326.dat, which is a binary file. The naming convention is the following:

- All log files begin with the name of the log group. The log group name consists of a letter followed by a number, that is, L0, L1, L2, L3, and so on.
- The log group name is followed by the date in the YYMMDD format.

In its Flash memory, MAWS can log everything it measures and calculates. The approximate log memory capacity can be checked and also printed in the **Setup information** view in MAWS Lizard when a

setup is created. The approximate maximum logging period for a setup where 10 measured values are logged is shown in Table 17 on page 138.

Table 17 Log Memory Capacity

Logging Interval	Maximum Logging Period
1 second	5 hours
10 seconds	over 2 days
1 minute	2 weeks
10 minutes	over 4 months
1 hour	Almost 2 years

Log files are automatically deleted after a given period, so that there is always a certain amount of logged data saved in the Flash memory. The period is adjustable in the setup and can vary from 0 (= at midnight, the previous day's file will be deleted to free up memory) to never delete (=log memory will be filled up completely). To ensure some data backup, for example, a value of 4 days is feasible. If the delete interval is set negative with MAWS Lizard Setup Software, the old log files will not be deleted automatically.

Log Data Format

A log entry is generated at the time defined in the setup file. When entries are retrieved with the **logshow** command, the produced output includes two parts: the header and the log entry information.

In Figure 121 on page 139, the example of a log query shows 10 entries of logged items 1 and 2 starting at 6 AM on December 9, 2003.

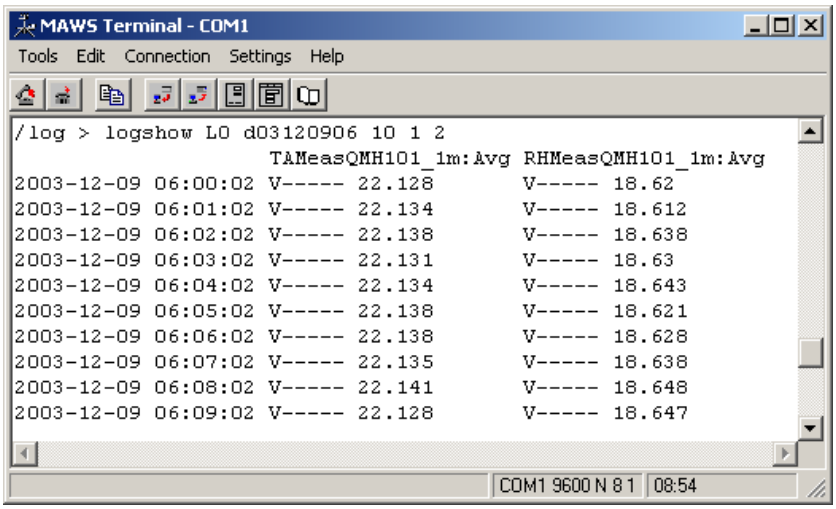


Figure 121 Output of the Logshow Command

The header information shows the variable name (TAMeasQMH101_1m:Avg and RHMeasQMH101_1m:Avg).

The log entry information includes the time tag, that is, date and time of the entry, the status, and the value of the logged measurement or calculation.

Table 18 Log Entry Status

Status Indicator	Status	Description
-I-----	Invalid	Value may be outside the set scale; that is, the set climatological limits or step change validation.
-I--N-	Invalid; not available	No measurements done yet.
V-----	Valid (normal)	Measurement or calculated value available normally.

Controlling Logging

Logging is automatically on if it has been defined in the setup and if it has not been stopped. Logging is automatically stopped when the log file is retrieved with MAWS Terminal. When download is accomplished, logging is activated again automatically.

When a sensor is replaced, stopping is not necessary if some invalid log items can be tolerated. Alternatively, instead of stopping logging, you

may manually disable a measurement or a sensor. For detailed information, see section Measurement Enable or Disable on page 140.

To see the logging groups, type **logstatus**. To see the current logging status of a certain group, type **logstatus** <*group_id*>. To stop or start the logging of a certain group, type **logstop/loggo** <*group_id*>. For the output of the commands, see Figure 122 on page 140.

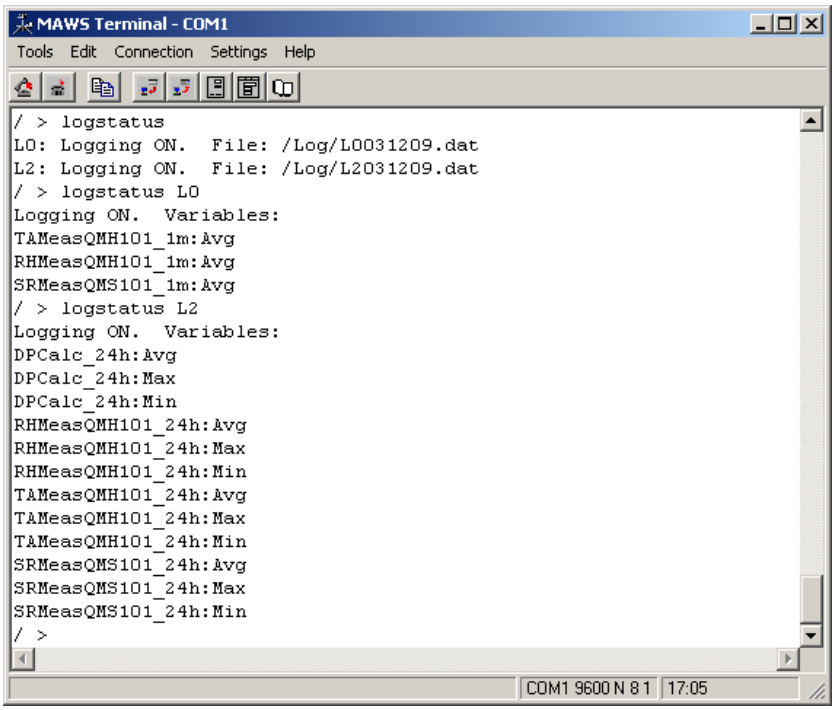


Figure 122 Output of the Logstatus Command

Measurement Enable or Disable

You can manually enable or disable all measurement inputs and sensors. You can use this feature, for example, for the following purposes:

- Remotely changing the readings of a faulty sensor to be flagged as invalid.
- Marking all sensor readings invalid during a maintenance operation.

Use the following commands in the service connection to change the flagging:

enable <*Measurement Name*>

disable <*Measurement Name*>

where

enable	=	Enables the measurement inputs or sensors.
disable	=	Disables the measurement inputs or sensors.
Measurement Name	=	The measurement name in the **Configuration** view of MAWS Lizard.

NOTE For sensors that use more than one input channel, you need to enter separate commands for each measurement. For example, you need to control separately the TA and RH measurements of the QMH101 sensor.

Examples:

```
>\ disable RHMeasQMH101_1
>\ disable TAMeasQMH101_1
>\ disable WMS302_1
>\ enable PWD10_1
```

Upon successful completion of the commands MAWS returns:

```
Successfully disabled
```

or

```
Successfully enabled
```

Any other returned values indicate an error.

When the measurement input is disabled:

- All other output values than status have undefined values.
- Sensor status shows `disabled`, refer to the updated list of the sensor statuses in Table 16 on page 132.
- Value status shows `INVALID` and `NOT AVAILABLE`.

Freeing Up Logging Space

A log file can be deleted with the **logdel** command:

logdel <*log_group_id*> <*(dYYMMDD)*>

where

logdel	=	The command to delete log files belonging to certain log group.
log_group_id	=	The name of the log group, that is, L0, L1, L2, or so on.
dYYMMDD	=	The date until which the log files will be deleted.

Example:

```
/ > logdel L2 d980910
```

To erase all data in the log system, type **LOGFS** *ERASE*. This command erases the whole Flash memory and resets MAWS. The command **LOGFS** *ERASE* is necessary to free space for new log data.

CAUTION	Erasing the log memory with **LOGFS** *ERASE* command is strongly recommended when changing a setup. First, load a new configuration and make sure it is operating correctly. Check that you have retrieved all the necessary information from the log memory, and then erase the log memory.

Working with Data Log Files

The most convenient way to view the logged data is to use MAWS Terminal. To do this, you need to open the service connection, download the files from MAWS to your PC and convert them to CSV (Comma Separated Value) format. After conversion, you can view the files directly in MAWS Terminal or, for example, in Microsoft Excel.

Before you start downloading files, you need to open the service connection by choosing the **Dial** option from the **Connection** menu. For more information on opening the connection, see section Opening MAWS Service Connection on page 120.

Selecting Files for Downloading

When you have opened the service connection to MAWS you are working with, you need to select the data log files you want to download. Choose the **Download log files** option from the **Tools** menu. The **Select Log Files for Download** window appears.

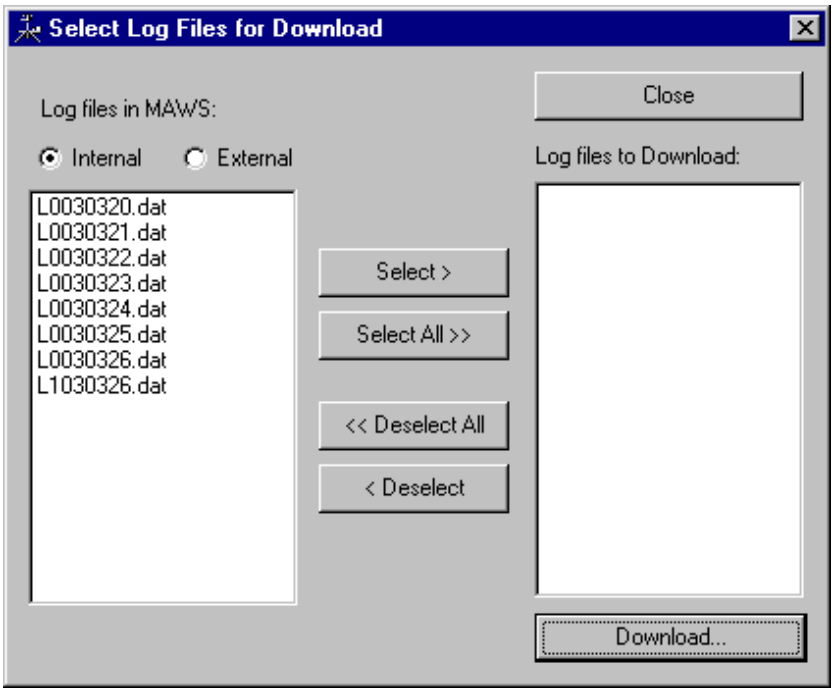


Figure 123 Select Log Files for Download Window

In the **Log files in MAWS** list, you see all data log files currently available in MAWS. The files are arranged by log group. Each log group includes specific parameters as defined in the configuration file.

Select the files you want to download and click **Select**. The files available for download appear in the **Log files to Download** list. If you use an external memory card, select the **External** option. You can select all files by clicking **Select All**.

If you decide not to download a file after all, you can remove it from the **Log files to Download** list by selecting it and clicking **Deselect**. To remove all files, click **Deselect All**.

NOTE	The program closes the service connection automatically after 5 minutes. If you fail to start the download within 5 minutes of selecting the **Download log files**, you need to reopen the MAWS Terminal program and start the download again.

Downloading Files

When you have selected the files you want to download, click **Download**, see Figure 123 on page 143. The **Set Download Preferences** window appears (unless you have defined otherwise in the **Preferences window - Show Dialogs** tab).

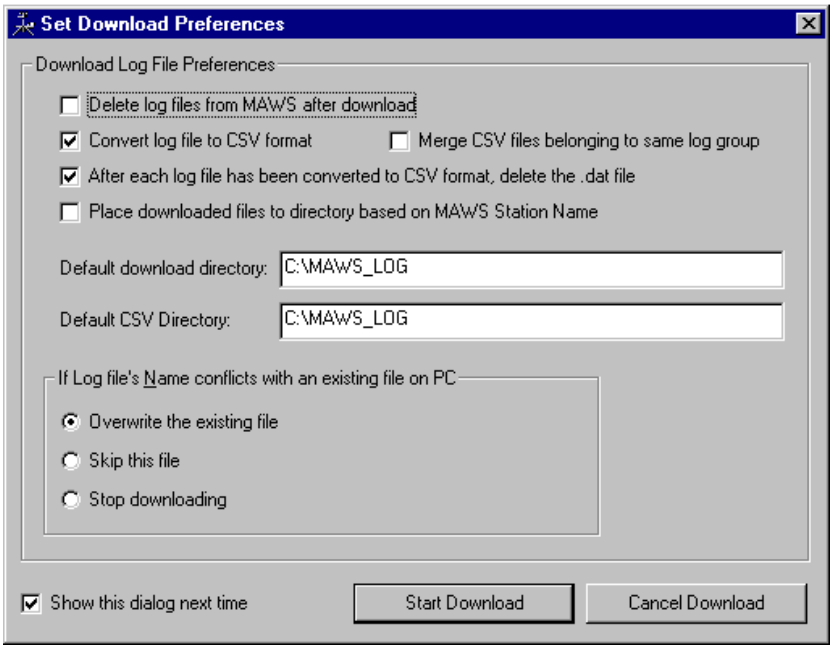


Figure 124 Set Download Preferences Window

Figure 124 on page 144 shows you the settings you can define for the download. If you want to change any of them, you can do it in this window. Then click **Start Download**. When the **Convert log file to CSV format** is selected, the program downloads the data log files to your PC and converts them to CSV format automatically.

In addition, you may select **Merge CSV files belonging to same log group** to merge the downloaded data files to one file. The log files are merged by the log group. The log group is indicated by the two characters at the beginning of the file name, for example, L0, L1, L2, or

L3. The name of the merged file will be in the following format:
`L0firstfilename - L0lastfilename.csv`

If you have selected that the data log files will be deleted from the MAWS memory after download, the program asks you to confirm this.

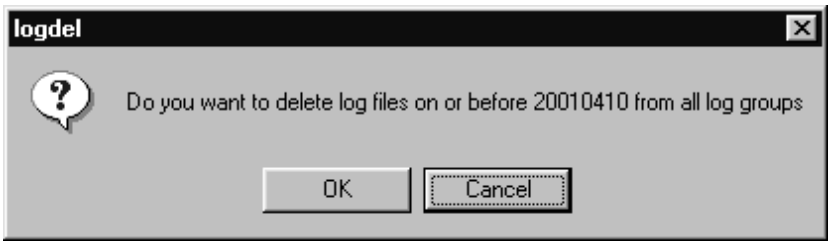


Figure 125 Confirming File Deletion after Download

CAUTION If you select **OK**, all files up to the mentioned date will be deleted, regardless of whether they have been downloaded or not.

Autodownloading Log Files

You can run MAWS Terminal in the AutoDownload mode. This mode allows you to download Log files automatically according to a user-defined schedule.

Before you change the application to the AutoDownload mode, a schedule must be defined. This is done in the window appearing when selecting **Settings - AutoDownload schedule**. The **AutoDownload Schedule** window is shown in Figure 126 on page 146.

In the **AutoDownload Schedule** window, you can define which stations to dial, when, and which log files to download.

NOTE To enable autodownloading you must have the MAWS Terminal software running continuously. In addition, the COM port must be free and assigned for MAWS Terminal.

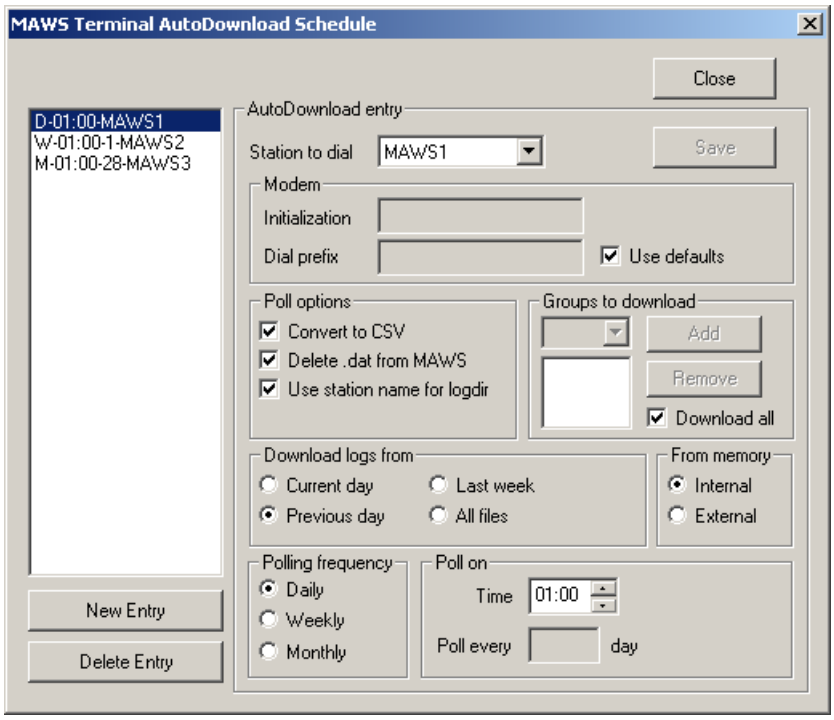


Figure 126 AutoDownload Schedule Window

When a station is equipped with a modem, you can either use the default modem initialization and dialing strings saved in Address Book or override them. You can enter the **Initialization** and **Dial prefix** values separately for each station.

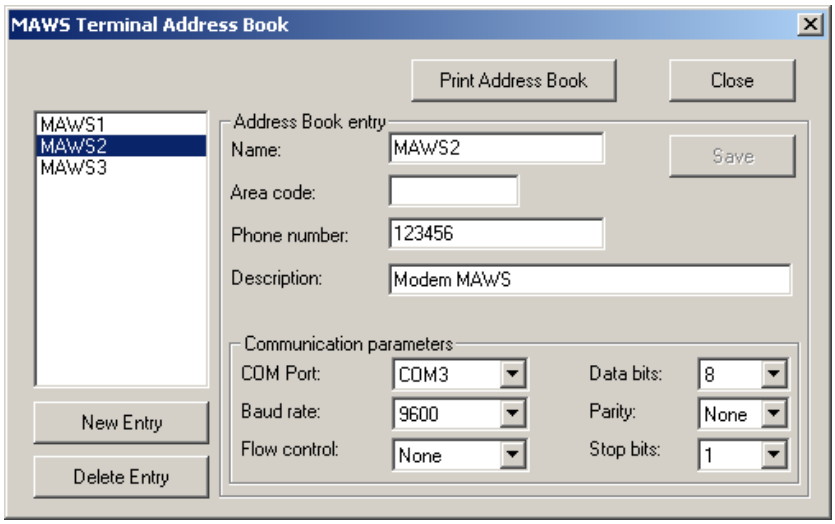


Figure 127 Address Book Entry for Modem Connection

Figure 128 Modem Options

When a phone number is entered into the **Phone number** field of the Address Book, the dial prefix entered in the **Dial prefix** field will be added to it. If the command which would be given manually in a terminal session is **ATD123456**, it is divided into a phone number (123456) and a prefix (ATD), see Figure 127 on page 146 and Figure 128 on page 147.

The scheduling of downloads is defined under **Polling frequency** as follows:

Daily – for scheduling a daily download from a station, at a certain time. You can set multiple daily polling times for one station. For example, in Figure 126 on page 146, the station called MAWS1 is polled daily at 01:00. The D character in the entry list stands for daily.

Weekly – for scheduling a weekly download from a station, at a certain time on a certain day. The **Poll every … day** field will be active, accepting values from 1 (Monday) to 7 (Sunday). You can set multiple weekly polling times for one station. For example, in Figure 126 on page 146, the station called MAWS2 is polled weekly on Monday (1st day) at 01:00. The W character in the entry list stands for weekly.

Monthly - for scheduling a monthly download from a station, at a certain time of a day of a month. The **Poll every … day** field will be active, accepting values ranging from 1 to 31. You can set multiple monthly polling times for one station. For example, in Figure 126 on page 146, the station called MAWS3 is polled the 28th day of each month at 01:00. The M character in the entry list stands for monthly.

CAUTION If there is a download scheduled on the 31st day of a month that has only 30 days, the download will not be made on that month.

Once you have set the schedule parameters, select **Connection - AutoDownload mode**. Selecting this item will open the **Operating in AutoDownload mode** window, see Figure 129 on page 148.

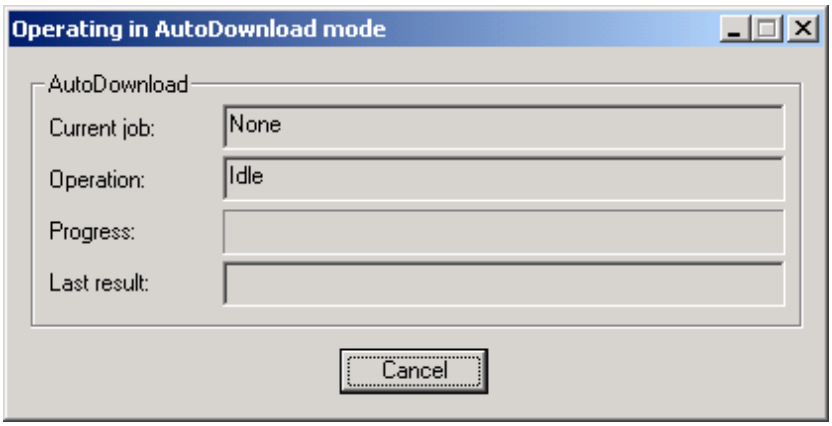


Figure 129 Operating in AutoDownload Mode Window

The application waits in idle mode until polling is triggered. When polling, the application automatically opens a service connection to a station and downloads log files as defined by the user, see Figure 130 on page 148.

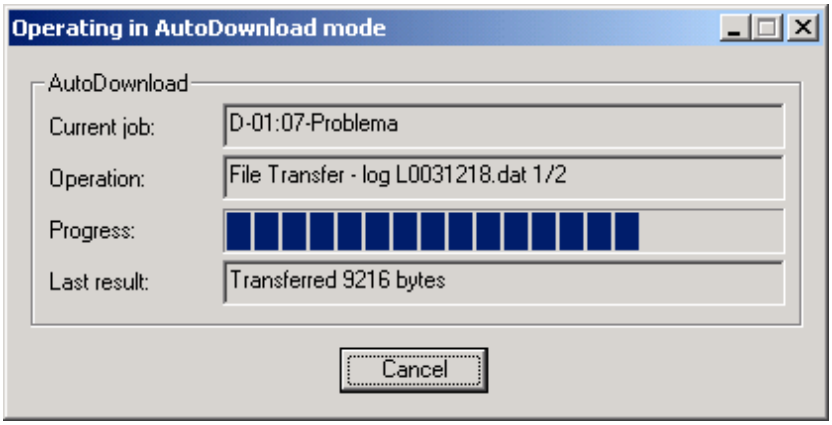


Figure 130 AutoDownload in Progress

When the log files are downloaded, the connection is closed and the application continues to wait in idle mode until a new pre-scheduled polling event is triggered. The **Last result** field displays **Session completed successfully** if all the tasks are accomplished without any problems, see Figure 131 on page 149.

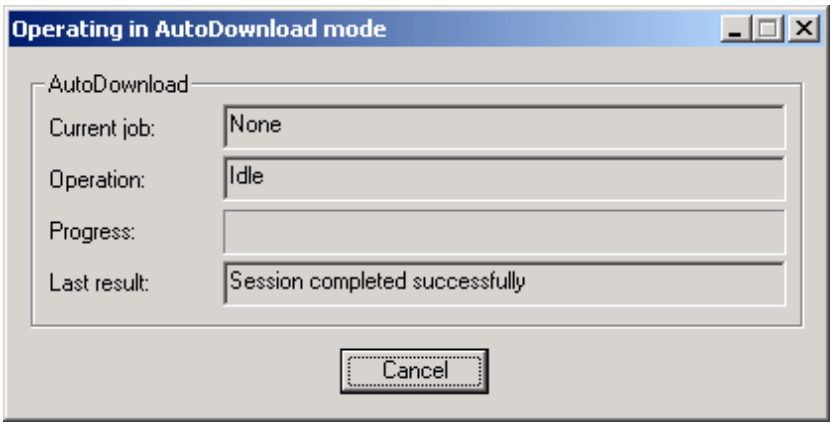


Figure 131 AutoDownload Completed

When you click the **Cancel** button in order to close the window, a work report will be shown, see Figure 132 on page 149. The **Info** window shows which stations were polled and the results of polling.

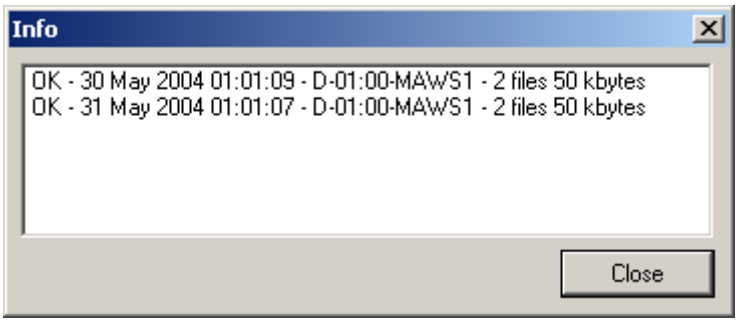


Figure 132 AutoDownload Info Window

Browsing Downloaded Files

You can browse the downloaded data log files directly in MAWS Terminal.

Choose the **Offline Log Query** option from the **Tools** menu. The window shown in Figure 133 on page 150 appears.

The default directory for data log files is the one you have specified in the **Preferences** window under the **Directories** tab. If the files you want to browse are located in some other directory, click **Change Directory**.

From the **Select Log Group** list, select the log group containing the file you want to work with. The files in that log group appear in the **Select**

Log Files box. Select the files you want. If you want to limit the number of data items on your screen, click **Select Data Items**.

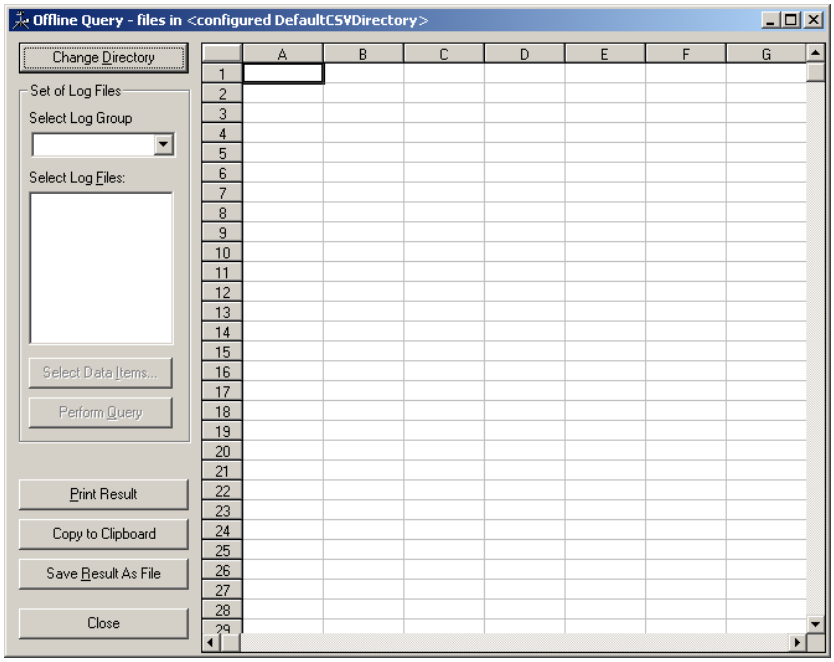


Figure 133 Offline Query Window for Browsing Data Log Files

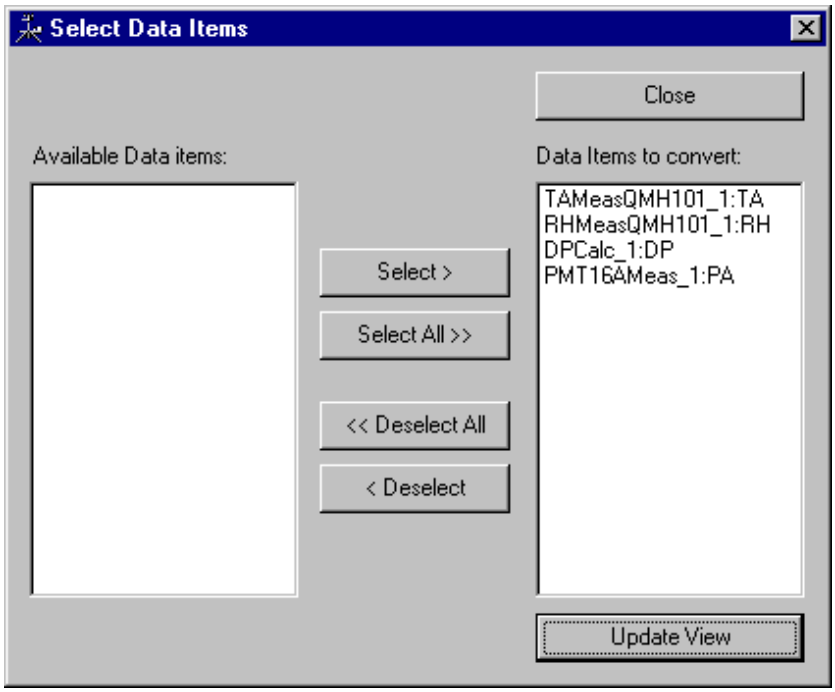


Figure 134 Select Data Items Window

In the **Select Data Items** window, you can select the data items you want to browse. By default all data items are selected. You can deselect any data item, or all of them. Once the data items you want are gathered in the right box, click **Close**.

Click **Perform Query**. The data items you selected appear on your screen in a table format.

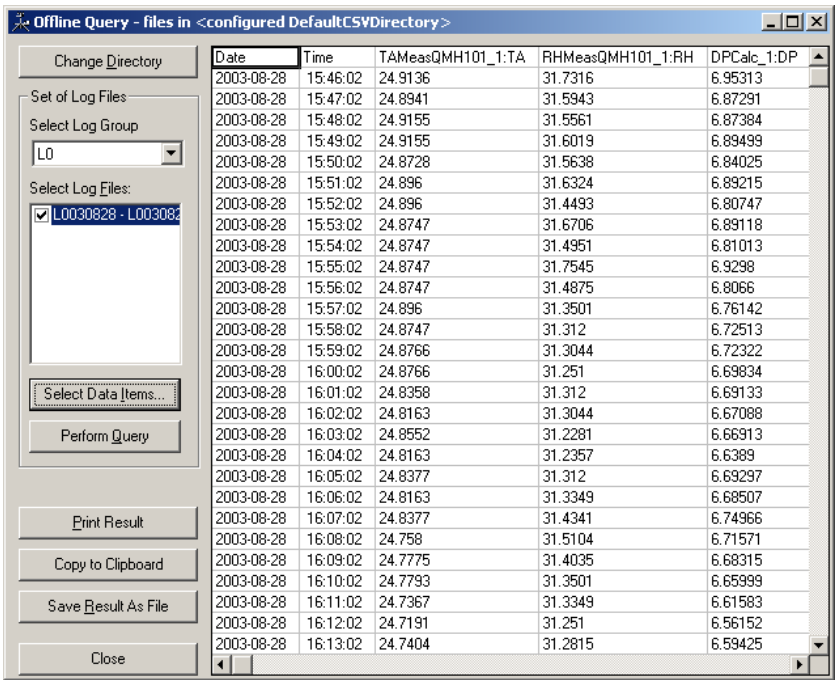


Figure 135 Offline Query Window with Data Items

If you want to view the table in Microsoft Excel, you must first save it in a tab-separated format. Click **Save Result as File**. In the window that appears, you can enter the filename and save the file in the directory of your choice. The default directory is the **Default download directory** you have specified in the **Preferences** window under the **Directories** tab.

When you have finished browsing the data log file, click **Close**.

Converting One Data Log File to CSV Format

If you have selected the **Convert file to CSV format** option in the **Preferences** window, in the **Download** tab, the program converts the data log files into CSV format as you download them. However, if you prefer to download the files without converting them, you can convert

them afterwards by choosing the **Convert Files to CSV** option from the **Tools** menu.

When you select the **Convert Files to CSV** option, the window shown in Figure 136 on page 152 appears.

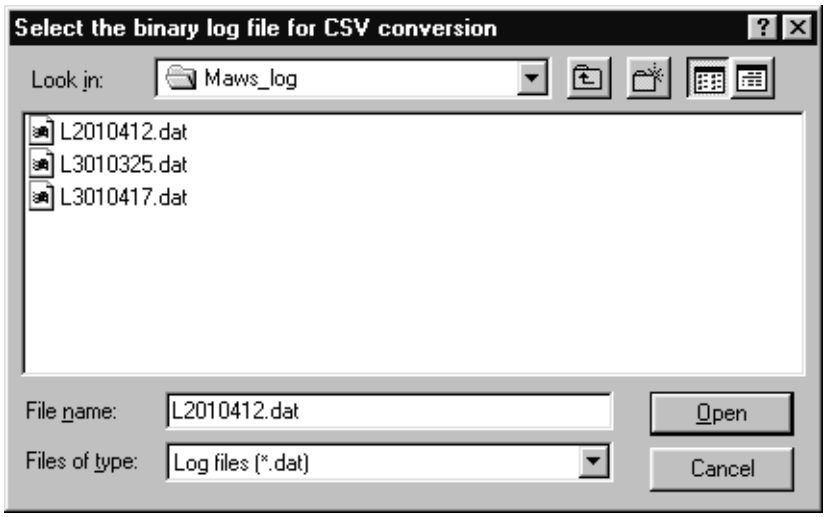


Figure 136 Selecting a Binary Log File for CSV Conversion

Select the file you want to convert to CSV format and click **Open**. The program starts the conversion. When the conversion is complete, the CSV file is saved in the directory you have specified in the **Preferences** window under the **Directories** tab.

Converting Several Data Log Files to CSV Format

If you prefer to download the files without converting them, you can convert several files afterwards by choosing **Convert many files to CSV** in the **Tools** menu.

When you select **Convert many files to CSV**, the window listing the available log files appears, see Figure 137 on page 153.

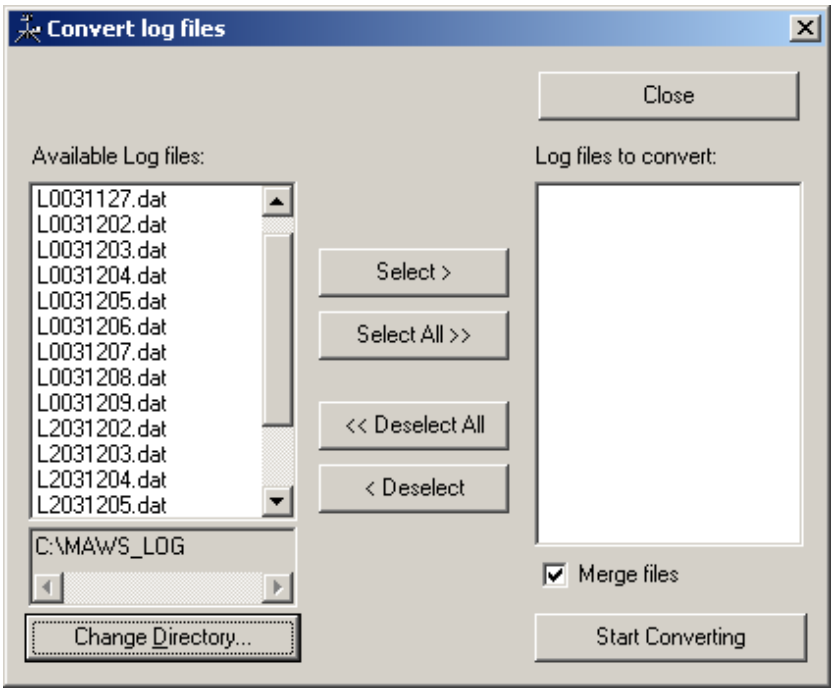


Figure 137 Converting Several Log Files to CSV Format

In the **Convert log files** window, you can select the log files you want to convert one by one, or select them all. Additionally, you can merge the files by selecting the **Merge files** option. Once the log files you want to convert are in the **Log files to convert** list, click **Start Converting**.

When the conversion is complete, the **Info** window appears. It shows which CSV files are created and where they are saved.

Using External Memory Card

The external memory card is used to store log files that have been copied or moved from the internal log directory. The data can be retrieved from the external memory card via terminal connection or by switching the memory card with an empty one.

Note that the memory card must be formatted with command **EXTFS** *ERASE* before use.

The external memory card can be removed from MAWS for data retrieval without interruptions to MAWS operations. MAWS copies data from the internal log directory to the memory card daily at midnight, the default time is 00:00:30. Data is being written when the

LED on the logger cover to the left of the external memory card is constantly on.

CAUTION	The memory card must not be removed from MAWS while data is being written, or the data may be lost. By default, data is transmitted to the memory card each day at 00:00:30.

When a new memory card is inserted into MAWS, the software checks that the card is ready for use. The status of the memory card is indicated by a LED. Table 19 on page 154 describes the different blinking sequences and the card conditions they indicate.

Table 19 LED Blinking Sequences and Card Status Options

Blinking Sequence	Card Status
Long-long	The card is OK.
Constantly on	Data is being written.
Short-short-short for 5 seconds	The card is unformatted or corrupted.

Automatic Erase from External Memory Card

The log group specific setting **Number of days to preserve log files** affects also the files stored to the external memory card. The functionality is the same as for internal log memory:

- Files older than the selected value [*days*] will be deleted automatically
- Files are not erased, that is, the automatic clean up is disabled

When files are stored to the external memory card, the internal memory is used as the working memory for storing the log files of the current day. These working files are moved to the external card each day just after midnight when the new files have been created for writing.

Resetting MAWS

To reset MAWS, give the command **reset** (recommended) or press the reset button, see number 1 in Figure 138 on page 155.

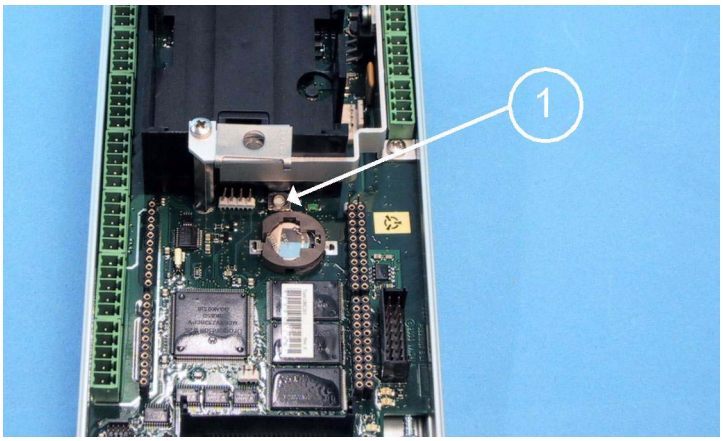


Figure 138 Reset Button on Logger

A short reset (pressing the reset button quickly) performs the same reset as giving the command and starts the program again. A long reset (pressing the reset button and keeping it down for a few seconds) restarts the program with a so-called blank setup. A blank setup does not run a configuration file.

Blank setup may be useful if the configuration is somehow defective and does not allow the user to open a terminal connection. When blank setup is run, the MAWS communication parameters are restored to their defaults: *COM0, 9600, N, 8, N, 1*.

Command Reference for Terminal Connection

Table 20 Command Set

Command	Description
altitude	altitude [*meters*]. To see the current station altitude, type **altitude**. To change the altitude, type **altitude** and the new station altitude in meters from sea level.
battery	battery [*capacity*] sets the capacity of the internal battery, needed for MAWS internal control. Accepted capacity values are 1.2 ... 24 Ah. To see the battery status, type **battery**. Note that the **battery** command applies only to the internal battery.
cd	cd [*directory path*] changes the current directory. **cd /** gets you back to the root directory. NOTE! cd .. Cannot be used.
chmod	chmod <*filename*> <*r/w/x*> changes the file access attributes: read (r), write (w) or execute (x). The setup file "Basic/Advanced/Lowpower" needs to have attributes rwx.
close	Closes terminal connection.
copy	copy <*source file*> <*destination file*> copies a file to another location.
del	del <*filename*> deletes a specified file. Only files that have (w)rite access attribute can be deleted (see command chmod).
dir	dir [*file/path*] displays a list of a directory's files and subdirectories, used and free disk space. The file information includes name, access_attributes, time, date and size.
disable	disable [*Measurement Name*] disables the measurement input or sensor.
enable	enable [*Measurement Name*] enables the measurement input or sensor.
errors	errors [*clear*]. To see active errors, type **errors**. To clear active errors, type errors clear. Errors indicate that there is something wrong in the software.
EXTFS	EXTFS <*INFO*|*ERASE*>. To format Compact Flash card, type **EXTFS** *ERASE*. To show card info, type **EXTFS** *INFO*. NOTE! The command must be written in upper case.
help	help [*command*] displays a command syntax. To list all the available commands, type help.
LASTVAL	LASTVAL [*Measurement*] [*raw* | *Signal name*] shows the measured value before any validation and the status produced during validation. The validated value is shown when you give the signal name that is defined in MAWS Lizard.
logdel	logdel <*log_group_id*> <*lastdate (dYYMMDD)*> deletes a log file/files dated earlier than the last given date.
LOGFS	LOGFS <*ERASE*> erases all data in the log system and resets MAWS. NOTE! The command must be written in upper case.
loggo	loggo <*log_group_id*> starts logging of the defined log group.
logshow	logshow <*log_group_id*> [*start (YYMMDDHH)*] [*count*] [*item numbers*] **logshow** *L1*shows one line of current day; **logshow** *L1 40* shows 40 lines; **logshow** *L1 40 3* shows 40 lines of item 3; **logshow** *L1 030618 10* shows 10 lines starting from 18.06.2003
logshownext	logshownext <*log_group_id*> [*count*]. After the **logshow** command, can be used to show the immediately following (later) log entries.

Table 20 Command Set (Continued)

Command	Description
logshowprev	logshowprev <*log_group_id*> [*count*]. After the **logshow** command, can be used to show the immediately preceding (earlier) log entries.
logstatus	logstatus [*log_group_id*] shows logging state and variables of the defined log group. The command without parameters shows statuses of all log groups.
logstop	logstop <*log_group_id*> stops logging of the defined log group.
md	md <*path*> creates directory. E.g. **md** */Ext/logdata*
move	move <*source file*> <*destination file*> copies a file to another location and removes the source file.
open	Opens the terminal connection.
pslevel	pslevel [*meters*]. To see the current pressure sensor level, type **pslevel**. To change the pressure sensor level, type **pslevel** and the new pressure sensor level in meters from the station altitude.
rd	rd <*path*> removes directory
rep	rep <*report_name*> shows contents of a report report_name. E.g. **rep** *MyRep0*
reset	reset [*delay (seconds)*] resets MAWS (warm boot). If the delay time is not typed, MAWS resets immediately.
serial	serial <*port_number*> [*speed*] [*parity*] [*bits*] [*stop*]. To see the settings of the port number 0, type **serial** *0*. To change the settings, type **serial** *0* and the new parameters. E.g. **serial** *0 9600 N 8 1*. Available ranges/options: Speed 300-19200, Parity N/O/E, Bits 7/8, Stop 0/1.
SLEEP	Sets MAWS in low power-state. Use the **SLEEP** command to reduce power consumption when storing the station for a few days (maximum period 1 month). Tip the spoon of the rain gauge to wake up MAWS. MAWS can also be woken up by pressing the reset button. NOTE! The **SLEEP** command must be written in upper case.
sname	sname [*station_name*]. To see the current station name, type **sname**. To change the name, type sname and the new name. If the station name begins with a digit or contains a space, the name must be in quotes e.g. **sname** *Vaisala MAWS*.
spclear	spclear <*parameter/ALL*> clears a static parameter/all parameters.NOTE! This command clears QMS101 and QMN101 sensitivity settings and is not usually needed.
spset	spset [*parameter*] [*value*] sets a value to a static parameter. To see a list of static parameters, type **spset**. NOTE! This command is not usually needed.
SYSINFO	SYSINFO gives information on the system. NOTE! The command must be written in upper case.
time	time [*HH MM SS YY MM DD*]. To see the current time, type **time**. To change the current time, type time and the new time. E.g. **time** *14 10 00*. To change the current date, type time and the new time and date e.g. **time** *14 10 00 98 12 31*.
timezone	timezone [*hours*] sets the time difference from UTC. To see the time zone, type **timezone**. To set the time zone, type e.g. **timezone** *2*.

Table 20 Command Set (Continued)

Command	Description
userlevel	userlevel [*level* <*set/clear*>] command is used to protect system from unauthorized use. It provides three password protected access levels to shell commands as well as to the visibility of system data. By default, the user levels are not in use.
verify	verify <*source file*> <*destination file*> compares two files, if they are different response is: `Error: Files are different`
warnings	warnings [*clear*]. To see active warnings, type **warnings**. To clear active warnings, type **warnings** *clear*. Warnings indicate that there are some problems in the software. See Chapter 7, Troubleshooting, on page 181 for more information.
winddircal0	winddircal0 [*direction*]. Set the direction in degrees to align the wind vane. Type for example **winddircal0** *360* (north).
zr	Zmodem receive command is needed when transferring the setup file to MAWS.
zs	zs <*file_name*>. Sends a file from MAWS using Zmodem protocol (used instead of MAWS Terminal function).

NOTE The following commands allow the use of wild cards: **chmod**, **dir**, **del**, **copy**, **move**, **verify**, and **zs**.

Example:

```
copy /log/L2*.* /Ext/log_L2copy
```

NOTE File commands (**dir**, **del**, **copy**, **move**, and **verify**) can be aborted by typing CTRL+C.

Disassembly of MAWS201 for Transportation

To disassemble the MAWS201 station for transportation, follow the procedure below:

1. Disconnect the power as follows:
   a. For short storage periods, set MAWS into low power consumption mode by giving the command **SLEEP** in MAWS Terminal.
   b. For long periods (over one month), disconnect the battery. First, open the hand screws that hold the tube in its place. Open the logger housing. Detach the red wire from the + terminal. Attach logger housing, lift the tube up and secure it with the hand screws.
2. Remove the cables from the upper and lower base connectors.
3. Detach sensor arm(s). Insert the screws back in their places for safekeeping.
4. Detach the telescope mast. Insert the screw back in its place for safekeeping.
5. Remove wind sensor by opening the plastic collar. Detach wind cable from the sensor.
6. Tilt the solar panel so that it is parallel to the tripod leg. Cover the panel by an opaque cover or other material before electrical connections to the modules or other system components are handled.
7. Loosen the locking screw, put the legs together and tighten the locking screw again.

WARNING	Be careful when drawing the tripod legs together. See that there are no power lines or other obstacles above the mast and the wind sensor.

Packing Instructions

For easy packing of the MAWS201 station, carry case sets are available as options. For an example, see Figure 139 on page 160 and Figure 140 on page 160.

Pack the sensors in the smaller carry case. Pack the tripod, upper tube, sensor arms, and accessories in the bag or bigger carry case.

Figure 139 QMM110 Carry Case Set

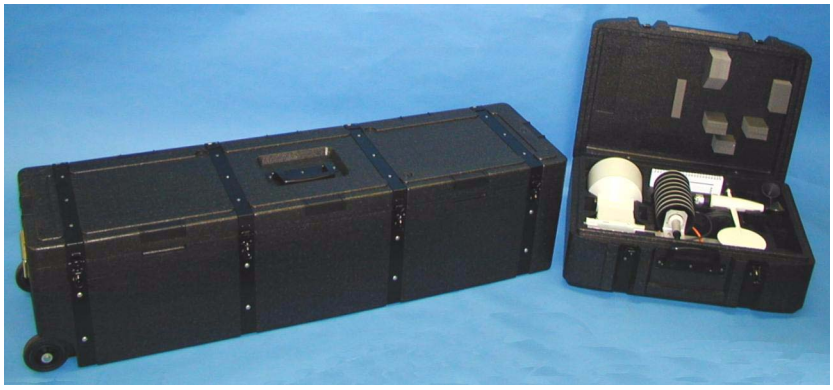


Figure 140 QMM120 Carry Case Set

CHAPTER 6

MAINTENANCE

This chapter provides information that is needed in the basic maintenance of MAWS, sensors, and accessories.

Routine Maintenance and Calibration

The purpose of periodic maintenance is to keep sensors operational and safe, measurements reliable, to define if any calibration actions are needed, and to extend the lifetime of the system.

Under normal conditions, the MAWS system needs only a minimum amount of maintenance. The need for maintenance depends on the sensors that are connected to your MAWS system.

CAUTION	Do not open the MAWS logger housing under poor conditions, for example, rain or dust in the air. In general, it is not advisable to repair sensors in the field.

Periodic routine maintenance tasks include checking, cleaning, and servicing all the system elements and repairing or replacing damaged or worn-out components.

The maintenance tasks should be accomplished only by a technician properly trained for these tasks. The technician must be familiar with the system and know how each component of the system performs. In addition, adequate tools and test equipment have to be at hand to complete the maintenance tasks successfully.

When using high quality sensors and system, most of the routine maintenance tasks can be performed at the installation site. Some instruments and advanced calibrations and refurbishments require the sensor to be returned to the laboratory for proper calibration. When system components need to be brought in from the field, the best procedure is to maintain an inventory of spare components. The user can then exchange a component with a calibrated component or sensor during a single visit. This is the case especially with sensors that must be returned to the manufacturer for calibration.

Before the maintenance actions, certain preparations must be made in order to make the work successful:

- Obtain information on how the site has been functioning before the scheduled maintenance.
- Obtain information on what maintenance tasks were completed during the previous maintenance procedure.
- Make sure that you have all the necessary tools available. The required set of tools depends on the system configuration, however the minimum is listed below:
    - A laptop PC with multiple fully charged batteries.
    - The latest operational versions of the MAWS operating software version, MAWS Lizard Setup Software, and MAWS Terminal software.
    - The setup file that is used at the particular station to be maintained.
    - All the necessary system documentation.
    - MAWS Terminal cable (QMZ101).
    - Hand held tools; screw drivers, wrenches, pliers, wire cutters, and insulation strippers.
    - Digital multimeter.
    - Clean cloth, cleaning solution, and cleaning brush.
    - Lubricant.
    - Anti-seize compound.
    - Safety harness, if tower climbing is required.
    - All the necessary parts to be changed regularly.
- Make a list of all the sensors requiring replacement with refurbished and calibrated units.

Overall Checking

- Check signal and main cables, connectors, and connections.
- Check gaskets of the enclosures.
- Check all grounding cables, lugs, etc.
- Check mechanical assemblies, bolts, nuts, etc.
- Check for corrosion. Repair if needed.

NOTE	Use the correct tools, which are of good quality.

Cable Maintenance

Inspect cables for breaks, cracks in the protective coating or cable connectors, and bent, damaged, or misaligned pins. Also wipe off or remove excess dirt, dust, sand, or leaves.

Updating Software to the Logger

In order to be able to utilize new features published by Vaisala, you may need to update the logger software.

CAUTION	Update the logger software only when requested by Vaisala.

NOTE	Note that there are certain incompatibilities between versions 5.01 and 4.07 or earlier but they have an effect only when upgrading the MAWS software.

In the MAWS version 5.01, the size of the configuration memory and the size of the internal logging memory have been changed. In earlier versions, the size of the configuration memory is 96 kB and the size of the internal logging memory is approximately 1.7 MB. Due to the need for larger configurations, from version 5.01 onwards the size of the logging memory is 224 kB and the size of the internal logging memory is slightly less than 1.6 MB.

In MAWS version 5.01, the floating point numbers use a 64-bit floating-point number (double). In the earlier MAWS versions, floating point numbers have been stored in the static parameters as 32-bit floating point numbers (float). When updating the logger software you need to restore the original values for this type of static parameters.

Copying a New MAWS Software with Loader Program

To update the software to the logger, follow the instructions below:

1. Check that you have the loader program **loader.exe** and the MAWS software **bin.mot** on your computer in the same folder.
2. By default the **loader.exe** application uses the **COM1** port of the computer. When you can use the **COM1** port, proceed with step a. below, otherwise proceed as instructed in step b.

NOTE	If any other COM port of the computer than **COM1** is used for loading the software to MAWS, you need to make a .bat file for software loading. Refer to step b. below.

   a. Connect the maintenance terminal cable to the port **COM0** of the MAWS system and to the **COM1** port on your computer.

   b. Connect the maintenance terminal cable to the port **COM0** of the MAWS system and to any free COM port on your computer. For example, if the free COM port is **COM3**, make the .bat file with Notepad, see Figure 141 on page 164.

      In the .bat file, the parameter *-s115200* indicates the bit rate (the default is 38400) and the parameter *-pCOM3* indicates the communication port (the default is **COM1**).

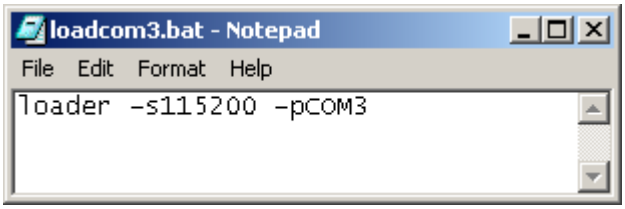


Figure 141 Making the .bat File in Notepad

3. Close any terminal connection to MAWS so that the serial port is free for software loading.
4. Close all other Windows programs.
5. To load the software, follow the instructions given in either a. or b.:
   a. When you are using the **COM1** port of your computer, open Command Prompt and change the directory to the folder where you have **loader.exe** and **bin.mot**. Type **loader** and press ENTER. The **Command Prompt** window shows `Waiting`.
   b. When you are using some other communication port, execute the .bat file created in step 2.b. The **Command Prompt** window shows `Waiting`.
6. Reset the logger by pressing the reset button.
7. The **Command Prompt** window shows `Erasing` for some time and then starts to show `Loading`. If you get a load error, try again from step 2.
8. After a few minutes, the display shows `Loading 100 %`.
9. The program restarts with an existing setup, and MAWS is now ready to operate. If you give the long reset to MAWS, it starts the program with a blank setup.

If you are having problems when loading software to the logger, for example, if loading is interrupted and you get the message `Load Error -1`, try again with all other Windows programs closed, except Command Prompt.

Loading may be interrupted due to a corrupted **bin.mot** file, or due to power save features, especially when a laptop computer is used.

Copying a New MAWS Software from Compact Flash Memory Card

As an alternative for updating MAWS software through the serial port using loader.exe you can receive a pre-programmed Compact Flash from Vaisala including the latest software to be copied. This requires that the boot version is also 4.07 or higher. The boot software is independent of the firmware software. Each time MAWS starts up, the boot software checks if a new software is available for loading on the CF card.

In order to copy a new software into MAWS, please follow the instructions below:

1. Check that MAWS includes a boot code that is version 4.07 or higher. The version can be read using the commands **VER** or **SYSINFO**.
2. Insert the Compact Flash card received from Vaisala into the Compact Flash slot of MAWS.
3. Launch copying the new software by issuing the command SWLOAD.
4. The MAWS software checks that the boot code is valid and the Compact Flash includes Motorola's S-record at the specified address. The firmware also checks that the Compact Flash is formatted and that there is a file on it named bin.mot.

   When the application has been copied, MAWS restarts automatically.

   If **SWLOAD** refuses to copy the new software, the reason can be one of the following:

   a. The Compact Flash card does not include a valid software.

   b. The boot code is too old.

5. When the new application has been restarted, take the Compact Flash card out of MAWS and store it for future use.

NOTE Typically, the boot code and firmware are new enough in new installations, but for upgrades both of them can be too old to perform this functionality. In this case, the only way to update the software is to download the software through the serial port.

NOTE As the Compact Flash card cannot be write-protected, take care that the card is not used for any other purposes, for example storing log files. Copying the firmware is successful only when there is one file on the card and it begins at the specified address.

Spare Parts

Available Spare Parts

Table 21 Available Spare Parts

Spare part name	For...	Order code
Cup wheel assembly	WMS302	WA45233
Anemometer bearing assembly	WMS302	WA45232
Vane assembly	WMS302	WA35234
Vane bearings assembly	WMS302	WA45247
Humidity sensor	HMP45D	HUMICAP®180
Temperature sensor Pt-100 IEC 751 1/3 Class B (HMP45D)	HMP45D	19159
Membrane filter (standard)	HMP45D	2787HM
HMP45D probe head	HMP45D	HMP45DSP

Ordering Spare Parts

Contact your local Vaisala representative for a complete list of spare parts and for ordering spare parts or optional units.

Solar Panel

Periodic Maintenance

WARNING Wear rubber gloves to protect yourself against possible electric shock.

CAUTION Do not use a scrub brush; it can damage the module front surface.

Inspect the module at least twice a year for overall integrity. Make sure that connections to the battery are tight and free of corrosion.

Dirt accumulation on the module's front surface can reduce the light energy collected by the module. If the module surface is dirty, gently clean it with a soft cloth or sponge using water and a mild detergent.

Weather Transmitter

Cleaning

To ensure the accuracy of measurement results, Weather Transmitter WXT510 should be cleaned when it gets contaminated. Leaves and other such particles should be removed from the precipitation sensor and the transmitter should be cleaned carefully with a soft, lint-free cloth moistened with mild detergent.

CAUTION	Be extremely careful when cleaning the wind sensors. The sensors should not be rubbed nor twisted.

Replacing the PTU Module

1. Turn the power off.
2. Loosen the three screws at the bottom of WXT510.
3. Pull out the top of the transmitter.
4. Release the small white flap and remove the PTU module.
5. Connect a new PTU module (order code WXT510PTUSP), replace the top and tighten the three bottom screws.
6. Turn the power on.

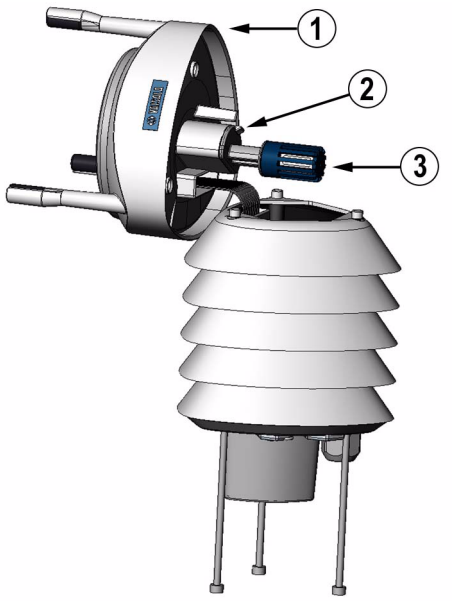


Figure 142 Replacing the PTU Module

Combined Wind Sensor

Periodic Maintenance

Testing Proper Operation

It is recommended to check the ball bearings of the anemometer and the vane every year. If the cup wheel or the vane is not rotating smoothly or it creates detectable noise, the bearings must be replaced.

Replacing Consumables

Only a trained technician should replace the bearings.

If your sensor includes the alignment sleeve and the factory alignment has not been altered, you can simply remove and remount the sensor to its place with the plastic collar without realigning.

To replace the ball bearings, do the following (the numbers refer to Figure 143 on page 171):

Anemometer bearings:

1. Loosen the hubnut (14) with fingers or a 10 mm tool and remove the cup wheel (13).
2. Remove the ball bearing assembly (12) by unscrewing it counterclockwise (with a 10 mm tool).
3. Insert a new bearing assembly (12). Tighten gently.
4. Fasten the cup wheel to the sensor. Tighten gently.

Vane bearings:

1. Proceed as described in steps 1 and 2 above.
2. Open the lock screw (11) of the tail assembly (10) and remove the screw.
3. Remove the Seeger-ring (9) (with narrow point pliers).
4. Remove the bearing assembly (8).
5. Replace the bearings inside the housing with new ones.
6. Assemble the sensor in the reverse work order.

Note that part number 6 in Figure 143 on page 171 consists of two parts. The lower portion has a notch that is aligned at the factory in relation to the output of the potentiometer to point north when the sensor is mounted.

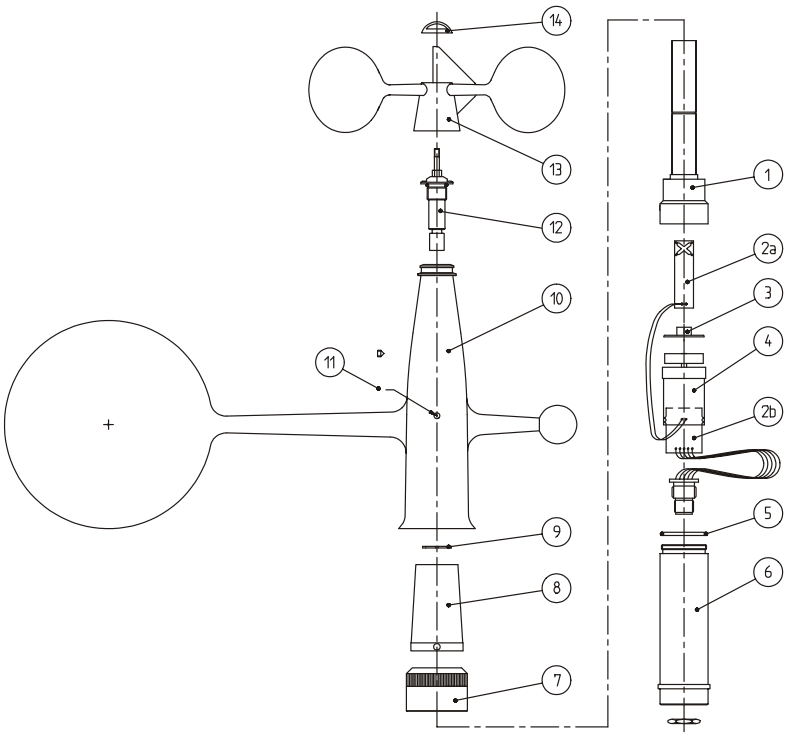


Figure 143 WMS Assembly

The following numbers refer to Figure 143 on page 171:

1 = Casing
2a = Reed switch PCB
2b = Potentiometer PCB
3 = Retainer
4 = Sleeve
5 = O-ring
6 = Base part
7 = Mast adapter sleeve
8 = Bearing assembly
9 = Seeger ring
10 = Tail assembly
11 = Lock screw
12 = Bearing assembly
13 = Cup wheel
14 = Hubnut

Air Temperature and Relative Humidity Sensor

Periodic Maintenance

Calibration and maintenance of the air temperature and relative humidity probe should be performed at regular intervals, depending on the conditions of use and desired accuracy. The validity of the readings should be checked annually.

The Air Temperature and Relative Humidity probes are easy to maintain and calibrate. The sensor consists of a probe head and a handle with cable. All calibration electronics are in the probe head, which can be disconnected from the handle without disconnecting the wires, as shown in Figure 144 on page 172. If you wish to continue the measurement immediately, you can insert a calibrated probe head in place of the disconnected one; this way the measurement is interrupted for less than a minute.

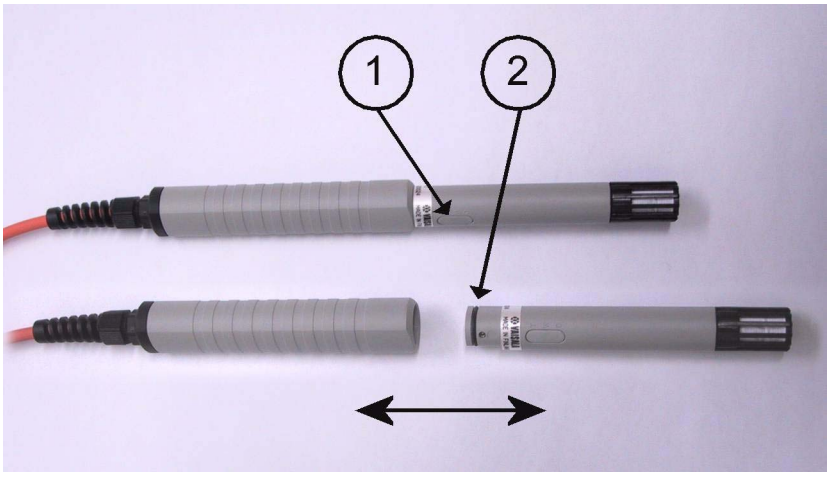


Figure 144 Probe Maintenance

The following numbers refer to Figure 144 on page 172.

1 = Adjustment trimmers: W = wet, D = dry, (T = temperature; for factory use only)

2 = O-ring for sealing the probe weather tight

Changing the HUMICAP®180 Humidity Sensor

Unscrew the filter. Remove the damaged sensor and mount a new HUMICAP®180 humidity sensor in its place. Handle the sensor with care. Calibrate the probe using a two-point calibration procedure.

Humidity Calibration

For a high-accuracy two-point calibration, use a Vaisala HMK15 calibrator and saturated salt solutions. Refer to the appropriate manual for details.

Easiest way of doing the calibration is to use HMI41 Indicator with the HMH40-MAWS Handle for the probe head. Note that this setup is only for relative humidity and no temperature readings are displayed.

Figure 145 HMH40-MAWS Handle

Leave the calibrator and the probe head in the same space for at least four hours so that their temperatures have time to equalize. Unscrew the plastic grid of the probe.

The calibration is done first for the dry end (<50 %RH) and then for the wet end (>50 %RH) by adjusting the trimmer potentiometers marked with **D** (dry) and **W** (wet). The potentiometers are located under a protective plug. Use a ceramic with 2.5 mm (0.1 in.) blade for adjusting the potentiometers.

NOTE	If zero point is calibrated in nitrogen (N2), the minimum output signal of 0.008 V corresponds to a relative humidity of 0.8 %RH.

Table 22 Greenspan's Calibration

Temperature [°C]	15	20	25	30	35
LiCl [%RH]	[1]	11.3	11.3	11.3	11.3
NaCl [%RH]	75.6	75.5	75.3	75.1	74.9
K2SO4 [%RH]	97.9	97.6	97.3	97.0	96.7

1. Do not use or store the LiCl solution in temperatures below +18 °C (64 °F) as its humidity equilibrium may change permanently.

As the **D** (dry) and **W** (wet) adjustments may affect each other, recheck the humidity reading at the low end. If necessary, repeat the adjustments in both the low and the high humidity points, until the reading is correct.

Pressure Sensor

Periodic Maintenance

Under normal operating conditions, PMT16A needs only a minimal amount of maintenance.

- Keep the pressure port clean. Check the pressure port every time when visiting the site.
- Annually, compare pressure values against a calibrated portable standard.

Calibration

The MAWS software provides means for one-point field calibration of the PMT16A sensor.

Required equipment:

- Laptop PC with a terminal software
- Travelling standard barometer (for example Vaisala PTB220TS)
- Terminal cable QMZ101 (included in the MAWS delivery).

Calibration procedure:

1. Establish terminal connection to MAWS by connecting the terminal cable to the COM0 port of MAWS and to an available I/O port on your PC.
2. Place both pressure sensors at the same level.

NOTE	Make sure that the wind does not interfere with the reading of the reference barometer.

3. Read the reference barometer reading.
4. Give this reference reading to MAWS.

   Type: **PMT16CAL** *1003.7* (reference reading *1003.7* hPa)
5. Check the readings given by MAWS.

   Value = reference reading

   Measured value = measured by MAWS

   Offset = measured value - reference reading
6. Repeat the calibration if necessary.
7. Close the terminal connection by giving the **close** command.

Rain Gauges

Periodic Maintenance of QMR101

To ensure reliable and accurate measurements, we recommend that the following checks be carried out at each visit to the rain gauge.

NOTE	If the gauge is still connected to the data logger and logger is operating, care must be taken to avoid tipping the spoon/bucket when carrying out the following operations.

1. Inspect the funnel for any damage or blockage. At certain times of year, leaves may have accumulated into the funnel. Dirt and dust can also block the grille preventing or reducing the flow rate to a slow drip to the buckets beneath. Remove all obstacles from the funnel.

2. Check that the gauge is still level. It is surprisingly easy for an apparently immovable gauge to become tilted as a result of small ground movements, vandalism, or just an inquisitive finger.
3. Clean the spoon from dust and dirt once or twice a year to ensure precise measuring.

Periodic Maintenance of QMR102

To ensure reliable and accurate measurements, Vaisala recommends that the following checks be carried out at each visit to the rain gauge.

NOTE	If the gauge is connected to the AWS logger and the logger is operating, avoid tipping the cup assembly.

1. Inspect the funnel and filter for any damage or blockage. At certain times of the year leaves may have accumulated in the funnel, dirt and dust can also block the filter preventing or reducing the flow rate to a slow drip into the buckets beneath. The leaves can easily be removed from the funnel and the filter can be cleaned by removing the end cap from the filter tube. Remove the filter material carefully, clean and replace the filter and cap.
2. Check that the gauge is still level. It is surprisingly easy for an apparently immovable gauge to become tilted as a result of small ground movements, vandalism or just an inquisitive finger.
3. Remove and clean any dirt from the bucket.
4. There will be times when the rain gauge will not log or will be disconnected from the logger. In such cases, it is a good idea to check the balance arm of the bucket for stiffness. The easiest way to do this in the field is to try to balance the bucket in its center position. It should be very difficult, if not impossible, to achieve this. If the bucket balances easily then examine the bucket closely for any dirt or wear on the pivot pin and bucket tubes.

Pyranometers

Periodoc Maintenance

The pyranometer is an all weather instrument. Once installed the pyranometer needs little maintenance. It is recommended that you clean the detector as part of a regular routine, using water or alcohol.

Re-calibration is suggested every two years. This can be done in two ways. The first is to compare with the measurement of a similar sensor at the same site. Daily totals of at least two days should be compared. Calibration factor should be corrected if results differ by more than six per cent. The second way is to let a re-calibration be performed at the factory.

If necessary, the sensitivity of the pyranometer can be adjusted. This can be done by soldering a resistor between the + (white) and - (black) output wires. In this way the pyranometer is shunted. For the standard pyranometer, the internal resistance is 47 Ω, and the cable resistance is 0.12 Ω/m. The cable is 3 m long. The cable resistance has to be multiplied by two, for the + and - wire. Total resistance is 47.7 Ω. In order to reduce the sensitivity by a factor of 10, when the full 3 meters of cable is used, a shunt resistor of 5.3 Ω can be made out of a 1 and a 4.3 Ω resistor. The order of magnitude for the sensitivity will be 10 μV/ Wm^{-2}.

The general formula for establishing the proper resistor for trimming by a factor of 10 is [47 + (0.24 × cable length)]/9. The cable length is in meters and the resistance is in ohms.

Net Solar Radiation Sensor

Periodic Maintenance

The Net Radiation Sensor is an all weather instrument. Once installed it needs little maintenance. It is recommended that you clean the detector as part of a regular routine, using water or alcohol.

Soil/Water Temperature Sensors

Periodic Maintenance

The QMT103/QMT110 sensor does not need any regular maintenance. Field repairs are accomplished by replacing the complete sensor.

When the QMT107 sensor is extracted, clean the dirt accumulation on the sensor surface with a soft cloth or sponge using water and mild detergent. Field repairs are accomplished by replacing the complete sensor.

Soil Moisture Sensor

Periodic Maintenance

The ML2x sensor is sealed after the factory calibration. It does not require any routine maintenance and it is constructed of materials selected for robust field operation. If the measurement rods become bent in use, they can be carefully unscrewed from the body and straightened. They have a right-handed thread. Pay careful attention to the following points:

- Do not remove the cross-head sealing screws. This may damage the seal and will void the warranty. No internal maintenance or repair shall be performed by the user.
- Do not remove the sensor from soil by pulling on the cable.
- Do not attempt to straighten the measurement rods while they are still attached to the probe body. This may break the rods or damage the case seal.

Soil Moisture Sensor

Periodic Maintenance

The ECH_2O-M3 sensor is sealed after the factory calibration. It does not require any routine maintenance and it is constructed of materials selected for robust field operation.

Submersible Water Level Sensor

Periodic Maintenance

To ensure reliable and accurate measurements, we recommend that during each visit to the Water Level Sensor the following checks be made:

1. Check the drying detergent through the window of the junction box.
2. If the drying detergent has turned red, change the cartridge. The cartridge has reached its internal maximum absorption of humidity. Replace the cartridge and adjust the interval for the next visit.

CAUTION	The drying detergent is very important to ensure reliable performance of the water level sensor. Otherwise humidity enters the sensor casing through the ventilation pipe inside the cable and causes severe damage to the sensor.

Leaf Wetness Sensor

Periodic Maintenance

Leaf Wetness Sensor does not need any regular maintenance. Field repairs are accomplished by replacing the complete sensor.

Fuel Moisture/Fuel Temperature Sensor

Periodic Maintenance

The sensing element of the sensor is a wooden dowel that exchanges moisture with its surroundings. In the course of a year, it undergoes many cycles of soaking up moisture and drying. These processes eventually cause the structure of the wood to deteriorate. Similarly, dust and other contaminants become embedded in the surface and they change the surface properties. When this occurs, the calibration is no longer valid.

The only way to restore the sensor accuracy is to replace the wooden dowel, which must be done at the factory.

Your experience will eventually determine how frequently the sensor needs service. At the beginning, the manufacturer recommends that you return it to the factory once per year for replacement of the dowel and calibration.

At most sites, where the sensor is used to assess fire danger, there is a season when the danger is low. That is usually a good time to replace or refurbish the sensor.

CHAPTER 7
TROUBLESHOOTING

This section consists of some common MAWS problems, their probable causes, and remedies.

Troubleshooting Procedure

When troubleshooting the MAWS system, write a failure notice consisting of the following issues:

- What failed (what worked / did not work)?
- Where did it fail (location and environment)?
- When did it fail (date, immediately / after a while / periodically / randomly)?
- How many failed (only one defect / other same or similar defects / several failures in one unit)?
- What was connected to the product and to which connectors?
- Input power source type, voltage and list of other items (lighting, heaters, motors etc.) that were connected to the same power output.
- What was done when the failure was noticed?

When troubleshooting the MAWS system, make sure you have the tools listed in Table 23 on page 182 available.

Table 23 Recommended Tools for Troubleshooting

Tools List
The terminal cable (QMZ101) and a laptop computer with the applicable versions of the setup files and the MAWS Terminal software
The keys for the enclosures
Multimeter
Flat-blade screwdrivers, especially small ones
Phillips screwdrivers, especially small ones
Set of open-end wrenches, different sizes
Set of Allen keys
Applicable spare parts, e.g., a new logger
Safety helmet when tilting the mast

Follow the procedure below to troubleshoot the MAWS system. Refer to the applicable sections of this chapter for details when requested. The basic procedure for troubleshooting assumes that the person has operating experience of the MAWS system.

1. Check the cabling and mechanical structure visually for indications of vandalism, dirt, lightning strike damage, or other visible cause for the problem. Also check that all the connectors are properly attached. For visual check of the enclosure and the logger, refer to section Visual Check on page 186.
2. The MAWS system appears to be completely down.
   a. Is the green LED on the QML201 logger blinking? Refer to section Determining MAWS Operation Mode on page 188. If not, check the following:
      - Is there sufficient voltage (8 ... 16 VDC) present in the EXT-DC input of the logger?
      - Is there the internal battery present? If there is, check it's voltage. Completely discharged or otherwise damaged battery can prevent the logger from operating. Refer also to section Battery Status on page 202.

   b. The logger has power but it is not functioning.
      - Connect the terminal cable and start the MAWS Terminal software. To establish the terminal connection, refer to section Establishing Terminal Connection on page 188.

- Open the logger cover and press the reset button. Refer to section Resetting MAWS on page 192. After a few seconds, the terminal should start to display logger startup messages.

c. MAWS is not sending anything (nothing is seen on the screen).

- After MAWS has been without power, for example when you start it for the first time, check the time and date. Timed operations will not work if the correct time is not set.
- The setup is faulty. Press and keep down the reset button for a few seconds. MAWS will restart and display the text `Using blank configuration`.

d. The logger starts up normally, but sends error messages during startup, for example, `!Erroneous setup file`.

- Reload the setup.
- Set the station parameters.
- Restart the system.

e. After uploading a new setup file, MAWS Terminal displays `Unhandled exception number: 39`.

- The setup might include too many calculations; consider removing some calculations.
- The interval between the statistical calculations is too short, consider executing the calculations less frequently. You might, for example, avoid calculations which are executed more frequently than the results are reported or logged.

f. If there are communication modules present, disconnect the power and replace the modules.

- Replace one module at a time and try to restart the system to find out the damaged one.
- Restart the system.

3. MAWS does not receive commands entered in MAWS Terminal.
   a. Check the terminal cable connection and that you have the correct terminal cable (QMZ101) in use.
   b. The terminal connection is not open.

      Type **open** and press ENTER. Note that the command must be typed exactly correct before it can be executed and that the command is not echoed on the screen.
   c. The port settings are not synchronous.

      Synchronize PC COM port and MAWS COM port settings.

4. Has someone made any software or hardware changes to the MAWS system prior to malfunction? If so, could those changes have an effect on the operation? You can capture the content shown in MAWS Terminal, refer to section Recording Terminal Connection Text on page 189.
   a. When you have loaded a new setup:
      - Make sure you have the original setup and the new setup saved as a .dtg file.
      - Reload the original setup and verify that the system starts and runs with the original setup.
      - Check the new setup once again with MAWS Lizard, reload it, and verify that the system starts and runs.
   b. When you have installed new hardware:
      - Disconnect the new hardware.
      - Reload the original setup and verify that the system starts and runs.
      - Check the new setup once again with MAWS Lizard.
      - Connect the new hardware.
      - Reload the new setup and verify that the system starts and runs.

5. Sensor(s) are not working properly.
   a. Are there one or multiple malfunctioning sensors? Multiple simultaneous sensor malfunctions in the same logger often indicate a damaged logger.

b. Check the output of the **warnings** and **errors** commands for indication of the probable cause.

- Connect the terminal cable and start MAWS Terminal. Type commands **warnings** and **errors**. For details, see section Warnings and Errors on page 199.
- Pay also attention to the message related to the excitation voltages. If the damaged sensor is powered by the logger, it may cause an overload.

c. If the malfunctioning sensor is measured by the logger:

- Open the sensor calibration view in MAWS Terminal, see section Determining Sensor Status on page 192.
- Check the sensor status and compare the value against the sensor status list in Table 29 on page 195.

d. If the malfunctioning sensor is a so-called intelligent sensor, for example, Vaisala Ceilometer or Vaisala Present Weather Detector, use its own diagnostic features.

- Connect terminal cable and start MAWS Terminal.
- Service interface for the intelligent sensors can be accessed through MAWS as explained in section Opening Service Connection Through MAWS on page 190.

6. Communication is not working properly.

a. Whenever possible, use an external device to verify that the communication infrastructure is working properly. For example, use a cellular phone to verify that the signal strength in the site is sufficient or that the SIM card in the MAWS system has access to the network.

b. Troubleshoot the modems as instructed in section GSM Modems.

c. If the communication device supports ASCII commands, for example AT commands for modem, this command interface can be accessed as explained in section Opening Service Connection Through MAWS on page 190.

7. Data is not stored to a memory card.

   a. Check the status of the memory card. It is indicated by a LED. Table 30 on page 196 describes the different blinking sequences and the card conditions they indicate.

   b. Check that the memory card has been formatted with the command **EXTFS** *ERASE* before use. For more information, refer to section Using External Memory Card on page 196.

Still not functioning? Replace the logger and return the damaged one to Vaisala for repair. For return instructions, refer to section Technical Support on page 206.

Visual Check

Open the enclosure, and check that all the equipment is present. Check that the logger, power supply, and communication devices are connected properly to the connectors inside the enclosure.

Remove the cover of the logger for visually checking the CPU board and other components located under the cover. In Figure 146 on page 187, the logger is shown without the cover and the optional communication modules.

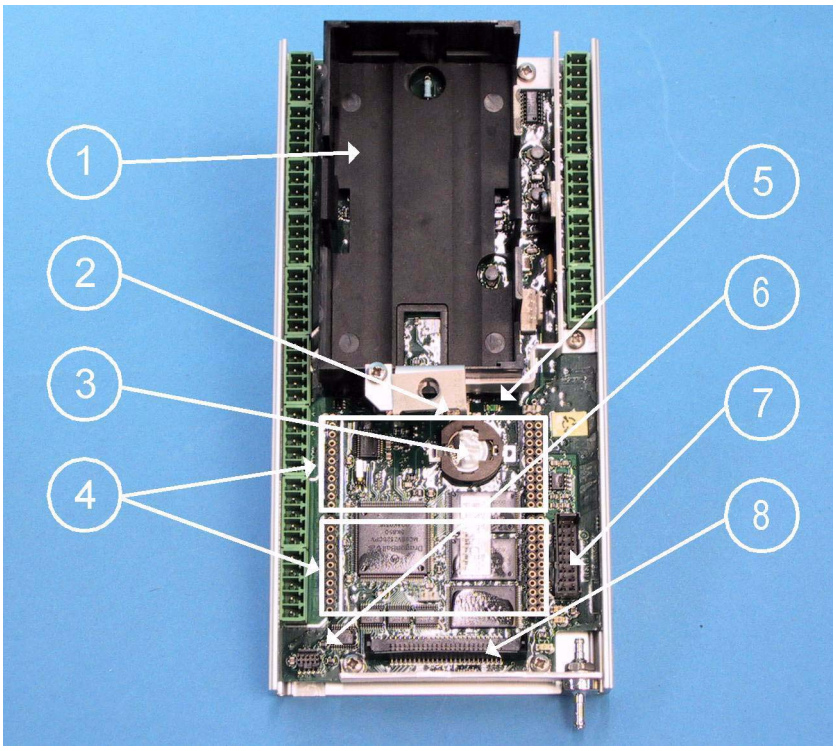


Figure 146 AWS Logger QML201 without Cover

The following numbers refer to Figure 146 on page 187:

1 = Place for the internal battery
2 = Reset button (under the bracket)
3 = Lithium battery for RTC
4 = Communication module places MOD1 and MOD2
5 = Status LED
6 = SPI connector
7 = Pressure sensor connector
8 = CF Card connector

Determining MAWS Operation Mode

You can watch the status LED to determine the MAWS operation mode. The LED is located on the MAWS logger board and it is visible through the logger cover.

Table 24 Determining Operation Mode by LED Flashing

LED Flashing Interval	Operation Mode	Note
All the time	MAWS has been reset but setup has not been examined yet.	
Once per 5 seconds	Setup is running.	
Once per 10 seconds	Blank boot or configuration cannot be run.	
Quickly 2 times	Setup is running but there are warnings.	Interval determined by setup.
Quickly 3 times	Setup is running but there are errors.	
Not at all	None	Check the power supply!

Establishing Terminal Connection

All MAWS software aided troubleshooting is performed using the service terminal connection. Some of the operations can be executed semiautomatically by the MAWS Terminal software, some require entering the commands manually.

To connect your computer to a MAWS serial port, proceed as follows:

1. Start the MAWS Terminal program on your PC.
2. Set the communication parameters: *9600, N, 8, 1*.
3. Give the command **open** (if the connection is not already open).

NOTE	The command **open** is not echoed on the screen.

Figure 147 on page 189 shows the pin order for the terminal connector.

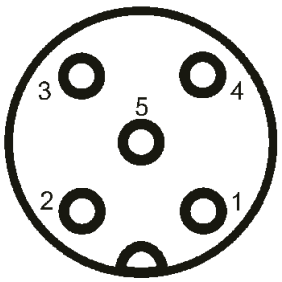


Figure 147 COM0 Pins for the Terminal Connector

The following numbers refer to Figure 147 on page 189.

1 = Not connected

2 = RxD

3 = GND

4 = TxD

5 = Not connected

Recording Terminal Connection Text

In problem situations, you can save the commands and program responses that you see in the MAWS Terminal window. Before you start creating the situation you want to record, clear the terminal buffer. From the **Edit** menu, select **Clear window**. The program removes all text from the terminal buffer.

To capture all the text shown in the MAWS Terminal window into a file, select **Capture all** from the **Connection** menu. The program starts saving all text into a file called *MAWS_Terminal.Log*. This file is stored in the **Default capture text directory** you have defined on the **Directories** tab in the **Preferences** window.

NOTE The **Capture all** selection remains on until you remove the selection from the **Connection** menu. Remember to remove the selection as soon as you have recorded enough messages, as otherwise it creates a large file that reserves your disk space.

When you no longer need the capture file, you can delete it from your PC. The capture file is called *MAWS_Terminal.Log* and it is saved in the **Default capture text directory** you have defined on the **Directories** tab in the **Preferences** window.

In problem situations, give the following commands: **battery**, **errors**, **spset**, **SYSINFO**, and **warnings**. When **Capture all** is selected, the results are saved into a file for future use.

Opening Service Connection Through MAWS

The command interface of the modem or an intelligent sensor can be accessed through MAWS, for example, to send the AT commands manually. To control the modem or sensor directly, open the service connection to MAWS, and, for example, when the device is connected to the DSU232's first communication port at the module place **MOD1**, type **open** *DSU232_0_0*. To terminate this operation, type **close**. While the direct connection to the modem or sensor is open, any automatic operation through the connected port is blocked. Typical parameters for the **open** command are presented in Table 25 on page 190. Information concerning the correct connector can be obtained in MAWS Lizard under **I/O Connections** in the **Equipment** view.

Table 25 Parameters for the Open Command

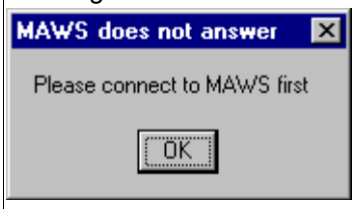
Connector in MAWS Lizard	Parameter
COM0	COM0
COM1	COM1
DSU232 (MOD1/1)	DSU232_0_0 [1]
DSU232 (MOD1/2)	DSU232_0_1
DSU232 (MOD2/1)	DSU232_1_0
DSU232 (MOD2/2)	DSU232_1_1
DSI486 (MOD1/1)	DSI486_0_0
DSI486 (MOD1/2)	DSI486_0_1 [2]
DSI486 (MOD2/1)	DSI486_1_0
DSI486 (MOD2/2)	DSI486_1_1 [2]

1. With DSU232 and DSI486 modules, the number between the underline characters stands for the module place, that is, MOD1 or MOD2, and the last number for the channel on that particular module.
2. With the DSI486 module, the RS-232 connection is possible only to the channel B on the module, and thus the last number is 1.

Connection Problems

If you can not connect to MAWS, the service connection is not opened and you can not work with MAWS. In case of connection problems, check the possible problems as instructed in Table 26 on page 191.

Table 26 Some Common Connection Problems and Their Remedies

Problem	Probable Cause	Remedy
You receive the following message: 	You are trying to connect to the wrong port.	Select the **Address book** option from the **Settings** menu to check the port numbers.
	Cables are not connected.	Check that the modem cable is connected properly.
You receive the following message: 	You are trying to connect to a port that does not exist in your computer.	Check the port settings.
	The port is reserved (some other program is connected to it).	It is possible that you have already opened the MAWS Terminal program, minimized the window and forgotten you have already opened it, and then tried to open the program again.
You do not receive any messages.	Cables are not connected.	Connect the cables as shown in section Establishing Terminal Connection on page 112.

Error Messages

When typing commands, you may encounter some error messages. Table 27 on page 191 explains the most typical error messages.

Table 27 Error Messages

Error Message	Probable Cause	Remedy
Error: Executable not found	Typing error.	Correct typing.
Syntax error!	Typing error: non-acceptable characters, e.g., +	
Error: Directory not found	Typing error in directory name.	
Error: Wrong number of parameters	A missing or an extra parameter.	Check the command syntax (**help** *command*) and give the command again.
Error: Missing parameter	A missing parameter.	

Resetting MAWS

To reset MAWS, give the command **reset** (recommended) or press the reset button, see number 1 in Figure 138 on page 155.

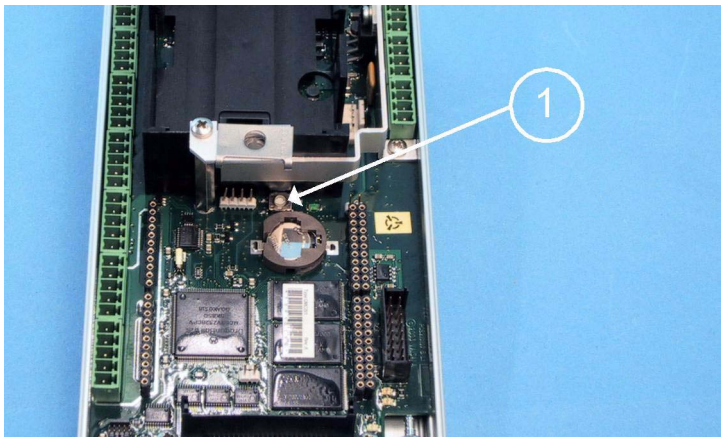


Figure 148 Reset Button on Logger

A short reset (pressing the reset button quickly) performs the same reset as giving the command and starts the program again. A long reset (pressing the reset button and keeping it down for a few seconds) restarts the program with a so-called blank setup. A blank setup does not run a configuration file.

Blank setup may be useful if the configuration is somehow defective and does not allow the user to open a terminal connection. When the blank setup is run, MAWS communication parameters are restored to their defaults: *COM0, 9600, N, 8, N, 1*.

Determining Sensor Status

Sensor status values give indication about the general status of the sensor interfaces. You have two alternatives to view the status value for a sensor:

NOTE	Sensors with their own measurement interfaces and algorithms, for example Vaisala Ceilometer or Vaisala Present Weather Detector, do not appear in the sensor list of the **Sensor Calibration** tab.

1. For any sensor enter the following service terminal command:

   LASTVAL *<measurement_name> status*

   For example:

   ```
   / > LASTVAL TAMeasQMH101_1 status Status:1 Value:0
   ```

   where

   Status:1 = The **Status** field in the output is the value status.

   Value:0 = The **Value** field shows the sensor status value.

   For details on the **LASTVAL** command, refer to section LASTVAL Command on page 198.

2. For conventional sensors, open the **Sensor Calibration** tab in MAWS Terminal, see Figure 116 on page 129. The list of the MAWS sensors is displayed in the tab. The **Status** column shows the sensor status. To read the latest sensor statuses and measurement values, click the **Refresh** button. Table 15 on page 130 describes the other columns in the **Sensor Calibration** tab.

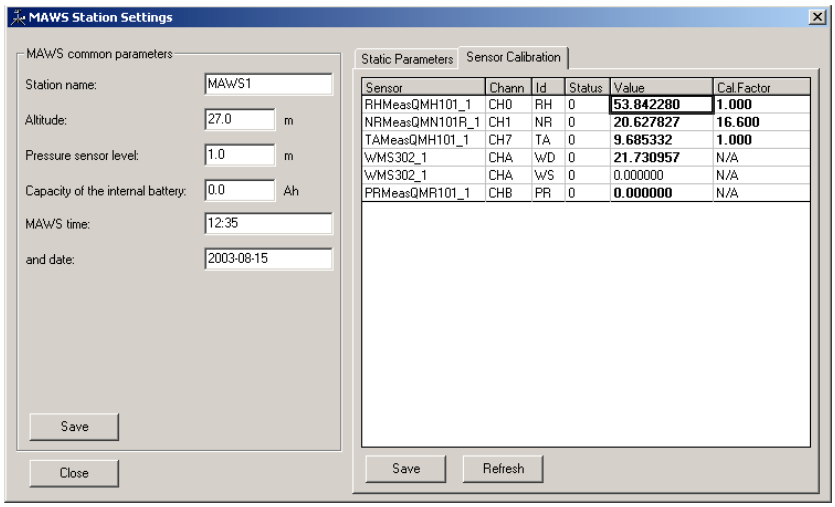


Figure 149 MAWS Station Settings Window: Sensor Calibration Tab

CAUTION When you upgrade a previous MAWS version to 3.06 or above, the following sensors will not operate correctly in the **Sensor Calibration** tab until they are removed from the setup and then re-created: CM6B, CM11, QMS101, QMS102, and QMN101.

NOTE You must load an appropriate setup to MAWS before you are able to use the **Sensor Calibration** tab.

NOTE The **Sensor Calibration** tab is not visible for setups made with MAWS software versions prior to 3.06. With old setups, **MAWS common parameters** frame only shows the calibration values for the wind direction and solar radiation sensors. Other sensors need to be calibrated through the terminal connection with the appropriate calibration commands.

NOTE When **Value** is expressed as `N/A`, it indicates that the calibration factor has been altered but not saved, the sensor has not been measured or the measurement channel of it has failed, or the sensor is disabled. Further information about the possible reason can be obtained by comparing the value in the **Status** column against the values listed in Table 16 on page 132.

Table 28 Columns in the Sensor Calibration Tab

Column	Description	Input
Sensor	The sensor name as defined in the setup.	n/a
Channel	The measurement channel of the sensor.	n/a
ID	The measurement identifier	n/a
Status	The sensor status	n/a
Value	The last measured sensor reading shown in physical units.	Overwrites the sensor reading with the entered value, that is, changes the offset of the measurement.
Cal.Factor	The measurement gain for the sensors, except for the radiation sensors (QMN10x and QMS10x) the sensitivity value.	Overwrites the old gain value with the new one. For radiation sensors (QMN10x and QMS10x), changes the sensitivity value.

Table 29 Sensor Status List

Value	Meaning	Notes
0	The sensor is working properly (OK).	
1	Not measured yet	
2	Interface is not initialized.	1
3	Communication time out has occurred.	1
4	Unknown data is received.	1
5	Communication is functioning, but the sensor reports errors. Use sensor's own service interface to find out cause.	1
6	Sensor communication is paused because service connection is opened through MAWS.	1
7	Message sequence numbers are overlapping in the Autotrac satellite transceiver interface.	1
8 ... 19	Not available	
20	Excitation failure is caused by the overload in the excitation output.	2
21	The input voltage is out of range or the A/D conversion has failed due to an internal error.	2
22	Sensor is disconnected or the connection cables are broken.	2
23	Sensor output exceeds the min/max limits defined in the **Measurements** view.	2
24	Change in sensor output has exceeded the maximum step defined in the **Measurements** view.	2
25	An internal configuration error has occurred.	2
26	Error in reference measurement, which is usually caused by damaged sensor/logger or electrical interference.	2
27	Internal voltage error occurred or the logger is damaged.	2
28	PMT16 calibration data error.	2
29	Data is invalid for unspecified reason.	2
30	The measurement or the sensor has been manually disabled.	
99	Sensor status is not supported.	

1. Value is available only for the sensors with the serial interface.
2. Value is available only for the sensors with a conventional, that is, analog or counter/frequency interface.

Using External Memory Card

The external memory card is used to store log files that have been copied or moved from the internal log directory. The data can be retrieved from the external memory card via terminal connection or by switching the memory card with an empty one.

Note that the memory card must be formatted with the command **EXTFS** *ERASE* before use.

When a new memory card is inserted into MAWS, the software checks that the card is ready for use. The status of the memory card is indicated by a LED. Table 19 on page 154 describes the different blinking sequences and the card conditions they indicate.

Table 30 LED Blinking Sequences and Card Status Options

Blinking Sequence	Card Status
Long-long	The card is OK.
Constantly on	Data is being written.
Short-short-short for 5 seconds	The card is unformatted or corrupted.

The external memory card can be removed from MAWS for data retrieval without interruptions to MAWS operations. MAWS copies data from the internal log directory to the memory card daily at midnight; the default time is 00:00:30. Data is being written when the LED on the logger cover to the left of the external memory card is constantly on.

CAUTION The memory card must not be removed from MAWS while data is being written or the data may be lost. By default, data is transmitted to the memory card every day at 00:00:30.

Automatic Erase from External Memory Card

The log group specific setting **Number of days to preserve log files** affects also the files stored to the external memory card. The functionality is the same as for internal log memory, that is, the following:

- Files older than the selected value [*days*] will be deleted automatically
- Files are not erased, that is, the automatic clean up is disabled

When files are stored to the external memory card, the internal memory is used as the working memory for storing the log files of the current day. These working files are moved to the external card each day just after midnight when the new files have been created for writing.

Commands for Troubleshooting Purposes

For most of the sensor inputs, there are data validation parameters to check the following measurement's quality parameters:

- Maximum value: the maximum climatological value for the sensor measurement.
- Minimum value: the minimum climatological value for the sensor measurement.
- Step change: the maximum step change for the sensor value between two consecutive measurements.

All of these parameters can be set by the user with MAWS Lizard Setup Software. For more information, refer to MAWS Lizard Setup Software User's Guide.

If the sensor value is outside the maximum or minimum values, or it has altered more than the maximum step change allowed, then data will be flagged as INVALID. Invalid data is typically displayed as ///// (this is a parameter that the user can set). If a sensor displays invalid data, this is an indication that the sensor is faulty or out of calibration, or there is a problem in powering or measuring the sensor.

LASTVAL Command

If the value in the report changes to ////, you can check the measurement's/sensor's value with the **LASTVAL** command. Give the command in the terminal connection. When you use the raw parameter, the measured value before any validation and the status produced during validation are shown. When you use the corresponding signal name, the validated value is shown.

LASTVAL [*Measurement*] [*raw* | *Signal name*]

where

Measurement	=	The name of the measurement as it is defined in the MAWS setup file.
raw	=	The parameter that gives the status and the value of the measurement before validation.
Signal name	=	The parameter that gives the validated value of the measurement.

Examples:

The command with the signal name parameter (in the following case TA) produces the following response:

```
/ > LASTVAL TAMeasQMH101_1 TA
Status:1  Value:20.490570
```

where

Status:1	=	The value is valid.
Value:20.490570	=	The validated value for the temperature measurement is 20.49xxxx

The measurement TAMeasQMH101_1 is defined in the setup file. The command with the raw parameter produces the following response:

```
/ > LASTVAL TAMeasQMH101_1 raw
Status:1  Value:20.490570
```

where

Status:1	=	The value is valid.
Value:20.490570	=	The raw value for the temperature measurement is 20.49xxxx

When the value in the report changes to ////, you can check the value. In the following case the probe is not connected:

```
/ > LASTVAL TAMeasQMH101_1 raw
Status:2  Value:-238.285549
```

where

Status:2	=	The value is invalid.
Value:-238.285549	=	The raw value for the temperature measurement is -238.285549, which means the probe is not connected.

When the value is invalid, check the sensor status value, and refer to Table 16 on page 132:

```
/ > LASTVAL TAMeasQMH101_1 status
Status:1 Value:0
```

where

Status:1	=	The **Status** field in the output is the value status.
Value:0	=	The **Value** field shows the sensor status.

Warnings and Errors

There may be some problems if you see either of the following prompts:

```
/ E>
/ W>
```

`/ E>` means that there are errors and `/ W>` means that there are warnings.

It is normal to have one or two warnings after the serial connection to MAWS has been reset, for example, if you have turned your PC off you can ignore these warnings.

To see active warnings, type **warnings**. To clear active warnings, type **warnings** *clear*. Warnings indicate that there are some problems in the software.

Example:

```
/ W> warnings
Warning: Break
  occurred 9 times first in uart.cpp[84]
  during thread: 00019F60 [AbsTimerT]
  object pointer: 106C [component: COM0]
Warning: Frame
  occurred 14 times first in uart.cpp[83]
  during thread: 00019F60 [AbsTimerT]
  object pointer: 106C [component: COM0]
```

The `Break` and `Frame` warnings mean that most likely you have turned your PC off and on again. This causes no trouble and you can clear the warnings.

```
Warning: Device reset
  occurred 1 times first in c:/libs/MAWS/adcl/kernel/
idle.cpp[52]
  during thread: 00001694 [Idle]
  object pointer: 163C [component: Idle]
```

The above warning means that you have reset MAWS. This causes no trouble and you can clear the warning. If you have not reset MAWS and the warning still occurs, contact Vaisala technical support (see section Technical Support on page 206).

```
Warning: Data missing
  occurred 2 times first in h:/MAWS/software/adcl/report/
confrep.cpp[414]
  during thread: 00019C0C [AbsTimerT]
  object pointer: 33A94 [component: MyRep1]
```

If you receive the above warning, check that **sname**, **pslevel**, and **altitude** are set.

To see active errors, type **errors**. To clear active errors, type **errors** *clear*. Errors indicate that there is something wrong with the sensors or configuration. Write down the error information and contact Vaisala technical support.

System Information

You can acquire a report that contains system information by using the **SYSINFO** command in MAWS Terminal. The command lists parameters that are useful especially when troubleshooting the system .

Example:

```
/ > SYSINFO
Serial #         : 59289091
Hardware         : Rev F
Software         : 3.02    Checksum  : 61577576
System RAM       : 1024kB
Free memory      : 583kB
Internal temp.   : 3.13'C
Active errors    : NO
Active warnings  : NO
Piggyback - 0    : DSU232 rev: B serial no: 009513
Piggyback - 1    : N/A
Extension board  : QMC102 rev: B serial no: V37306
System uptime    : 65h 20min 27sec since Fri Jan 10 16:35:39
2003
/ >
```

where

Serial #	=	The serial number of the logger PCB.
Hardware	=	The hardware revision of the logger PCB.
Software	=	The software version for the operating software and its checksum.
System RAM	=	The total amount of memory on the logger.
Free memory	=	The amount of free memory on the logger.
Internal temp.	=	The internal temperature of the logger.
Active errors	=	The existence of active errors: YES/NO
Active warnings	=	The existence of active warnings: YES/NO
Piggyback - 0	=	The type and serial number of the additional module installed in the module slot 1.
Piggyback - 1	=	The type and serial number of the additional module installed in the module slot 2.
Extension board	=	The type and serial number of the optionally installed memory expansion board.
System uptime	=	The total time that the system has been running, calculated from the last reset.

Battery Status

You can view battery status information by giving the command **battery** without parameters.

NOTE	The **battery** command applies only to the internal battery of the logger.

Example:

```
/ > battery
Remaining=100
State=FLOAT_CHARGE
U=6.850195
I=2.685547
Type=PB_BATTERY
Capacity=1.200000
Ext.DC=8.132420
Internal temperature=23.511668
```

Battery voltage (U) and voltage at the +ExtDC terminal are given as volts, charging current (I) as milliamperes and capacity as ampere-hours. The remaining percentage shows how much energy is left in the battery.

If you suspect that the internal battery or the charging circuitry is defective, try the following:

- Check that the battery capacity is correct and change it with **battery** [*capacity*] command, if necessary. If the capacity setting is too low, the battery simply charges slowly. In the opposite case, the battery may be damaged due to too high charging.
- Check the battery voltage, ExtDC voltage and charging current. ExtDC should be higher than battery voltage for charging. If it is lower, battery is discharging and charging current shows negative value. Normally, battery voltage should vary between 5.8 and 7.0 volts and it may rise as high as 7.5 volts during quick charge (for lead batteries).

Measurement Enable or Disable

You can manually enable or disable all measurement inputs and sensors. You can use this feature for example for the following purposes:

- Remotely change the readings of a faulty sensor to be flagged as invalid.
- Mark all sensor readings invalid during maintenance operation.

Use the following commands in the service connection to change the flagging:

enable <*Measurement Name*>

disable <*Measurement Name*>

where

enable	=	Enables the measurement inputs or sensors.
disable	=	Disables the measurement inputs or sensors.
Measurement Name	=	The measurement name from the **Configuration** view of MAWS Lizard.

NOTE For sensors that use more than one input channel, you need to enter separate commands for each measurement. For example, you need to control separately the TA and RH measurements of the QMH101 sensor.

Examples:

```
>\ disable RHMeasQMH101_1
>\ disable TAMeasQMH101_1
>\ disable WMS302_1
>\ enable PWD11_1
```

Upon successful completion of the commands MAWS returns:

```
Successfully disabled
```

or

```
Successfully enabled
```

Any other returned values indicate an error.

When the measurement input is disabled:

- All other output values than status have undefined values.
- Sensor status shows `disabled`; refer to the updated list of the sensor statuses in Table 16 on page 132.
- Value status shows `INVALID` and `NOT AVAILABLE`.

Battery Regulator

Table 31 Battery LEDs

LED	Color	Explanation
Battery status LED	Green	Charging
	Blank	Not charging
Charge LED	Green	OK
	Orange	Low
	Red	DC off

Solar Panel

Table 32 Troubleshooting the Solar Panel

Problem	Probable Cause	Remedy
The power output has decreased.	The module surface is dirty	Gently clean it with a soft cloth or sponge using water and mild detergent.

Combined Wind Sensor

Table 33 Troubleshooting Combined Wind Sensor

Problem	Probable Cause	Remedy
The data is not received from the sensor.	The sensor is mechanically damaged.	Check the cables and connectors.
	The sensor is not powered properly.	Check that the supply voltage is from 3 to 15 VDC.

Air Temperature and Relative Humidity Sensor

Table 34 Troubleshooting the Air Temperature and Relative Humidity Sensor

Problem	Probable Cause	Remedy
You receive no data.	Cable is not connected.	Check the cable connection.
The data seems to be incorrect.	The installation site is not correct.	Select a new location according to the installation instructions.
	The probe requires calibration.	Calibrate the probe according to the separate instructions.

Soil Temperature Sensor

Table 35 Some Common Problems of QMT107 and their Remedies

Problem	Probable Cause	Remedy
You receive no data.	Improper cable connection.	Check cable connection.
	The probe is not powered.	Check the presence and correctness of the line voltage.
	Cable failure.	Check cable integrity.
The data you receive seems to be incorrect.	The probe in not properly inserted.	Drill a new hole for the probe.

Technical Support

When contacting Vaisala technical support, please send the following information with your technical enquiry or description of a fault:

- Serial number of the MAWS logger.
- The captured text of the **SYSINFO** command.
- If you have modified the setup file, and the setup is possibly defected, please send also the captured *MAWS_Terminal.log* file and the setup file (.dtg). Refer to MAWS Lizard User's Guide for instructions on how to export a setup file.

For technical questions, contact the Vaisala technical support:

E-mail helpdesk@vaisala.com

Fax +358 9 8949 2790

If the product needs repair, please follow the instructions below to speed up the process and to avoid extra costs to you.

1. Read the warranty information.
2. Contact Vaisala technical support via e-mail or fax and request for RMA (Return Material Authorization) and shipping instructions.
3. Proceed as instructed by Vaisala technical support.

NOTE	RMA must always be requested from Vaisala technical support before returning any faulty material.

CHAPTER 8
TECHNICAL DATA

This chapter provides the technical data of MAWS and its sensors.

Connector Block Descriptions

The MAWS logger includes:

1. Ten measurement channels and one internal channel for pressure measurement.
2. One connector block for power supplies.
3. One connector block for communication channels.
4. Two blocks for optional communication modules.

Single-ended (H-C or L-C) or differential (H-L) measurements can be performed in the 10 measurement channels.

NOTE Each sensor of the basic configuration has its own dedicated channel. Table 36 on page 208 is to be used for reference purposes only.

Table 36 Description of Analog Measurement Channels

Channels	Pin name	Description
CH0, CH1, CH2, CH3 16-bit ADC	E	12 V / 25 mA voltage excitation ON/OFF, voltage can be measured. OR: 100mA/ 1mA current excitation.
	H	Analog input (High)
	L	Analog input (Low)
	C	The pin has been connected to ground (GND) via a 10 Ω resistor so that the current can be measured.
CH4, CH5, CH6, CH7 16-bit ADC	E	100 mA / 1 mA current excitation
	H	Analog input (High)
	L	Analog input (Low)
	C	Common return and reference level for voltage measurements via the channel's own E-, H- and L-pins. The pin has been connected directly to ground.
CHA, CHB Suitable for fast-changing input signals 12-bit ADC	F	Frequency input
	E	0 ... 12 V / 20 mA adjustable excitation voltage, can be measured.
	H	Fast analog input (High)
	L	Fast analog input (Low)
	C	Common return (Analog ground)

Table 37 Description of the Power Channel

Pin name	Description
GND	Ground
+BATT	5 ... 14 V
GND	Ground
+ExtDC	8 ... 16 V

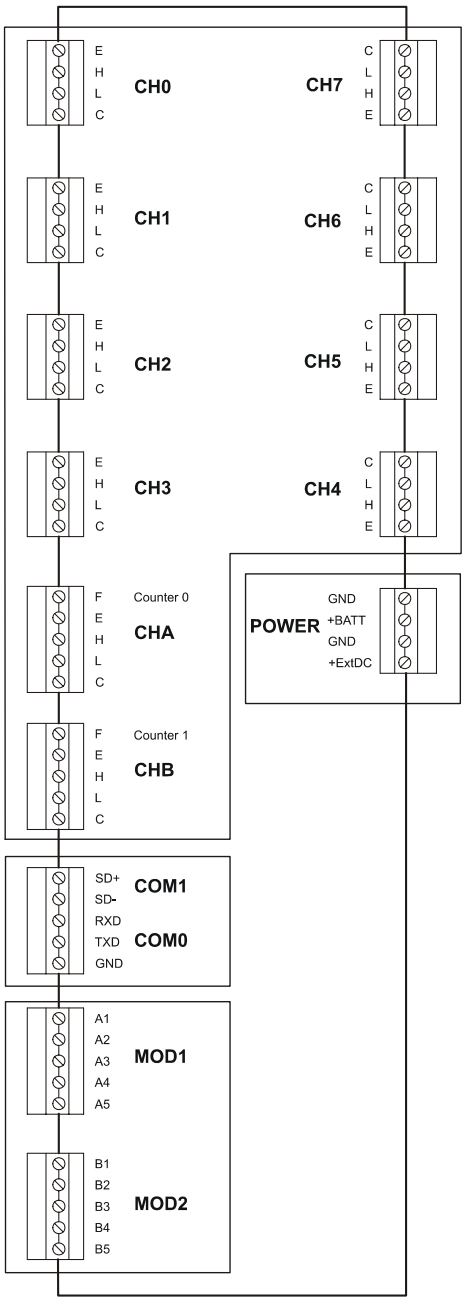


Figure 150 Connector Blocks

Wiring Instructions

For the basic set of sensors, wiring has been done at the factory according to Figure 151 on page 211. The numbers next to the plug connectors indicate poles for connection wires.

For the wiring diagram of MAWS201 equipped with Weather Transmitter WXT510, see Figure 152 on page 212.

Do not change the wiring between the connectors and logger pins. For special deliveries or with some sensors, a separate wiring diagram is supplied in order to help you connect the sensor wires to correct connectors.

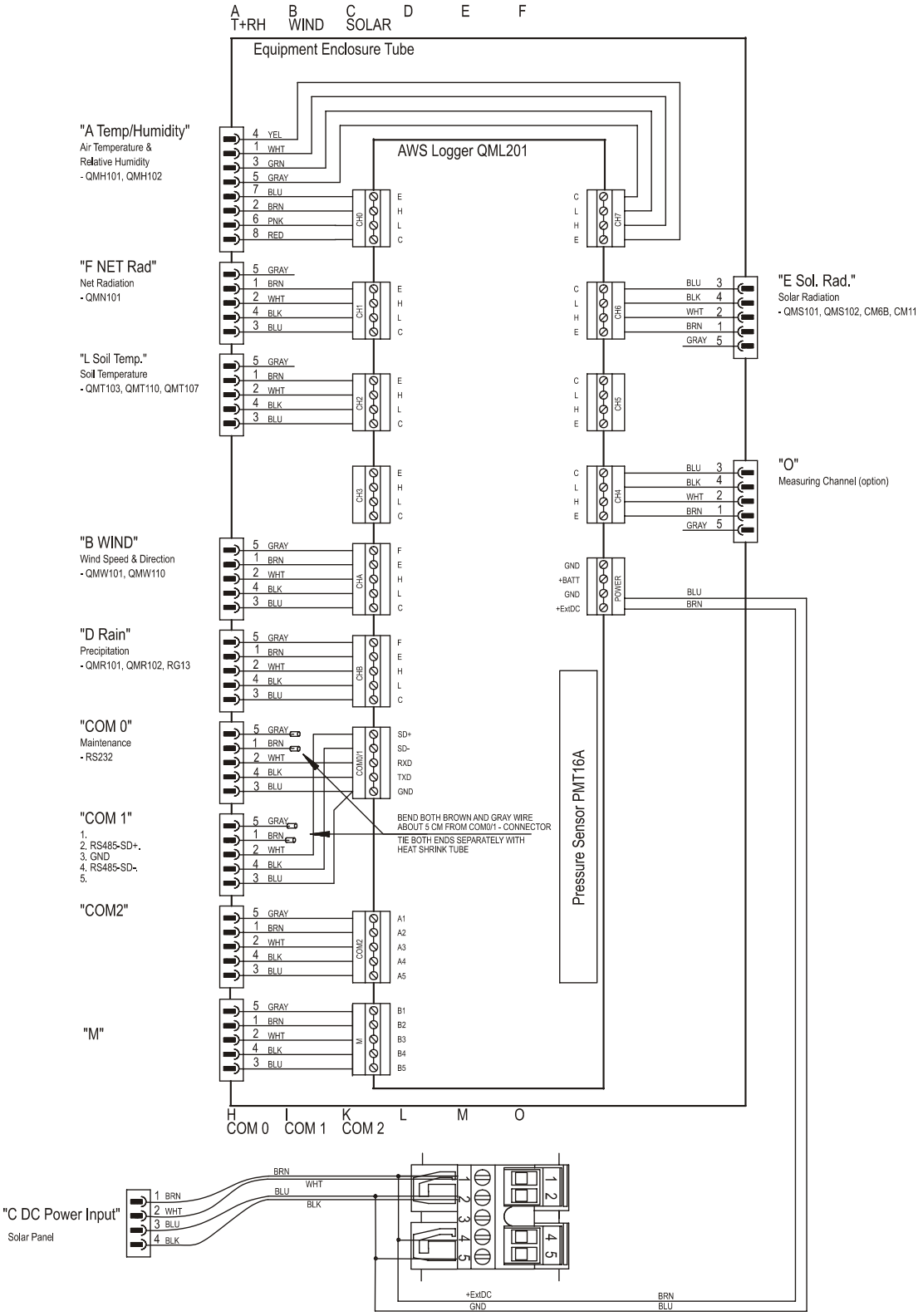


Figure 151 MAWS101/MAWS201 Basic Wiring Diagram

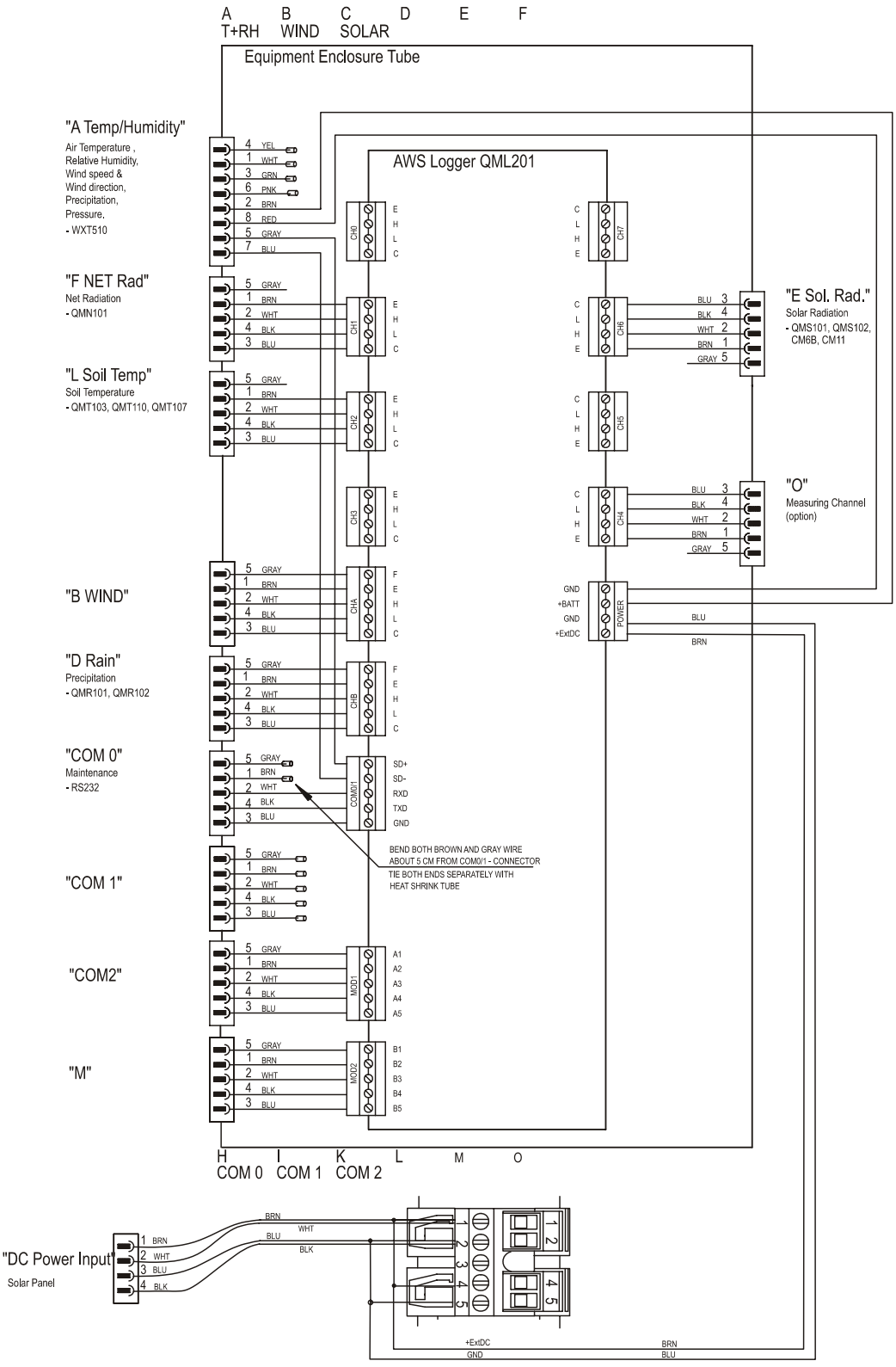


Figure 152 Basic Wiring Diagram for MAWS201 with WXT510

DSU232

DSU232 is an unisolated RS-232 module that will provide either a double serial channel without handshaking or a single RS-232 with handshaking. It can also feed 12 V (45 mA) for a serial sensor, when used in sensor mode.

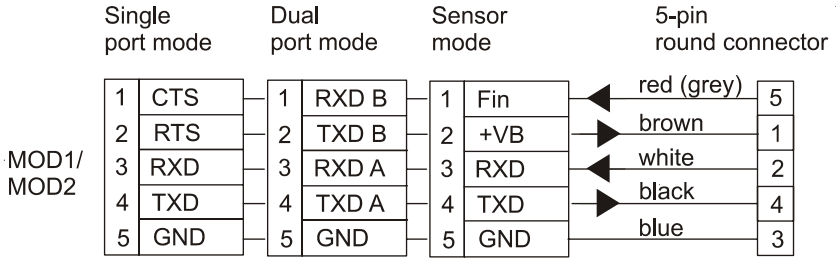


Figure 153 DSU232 Wiring Diagram

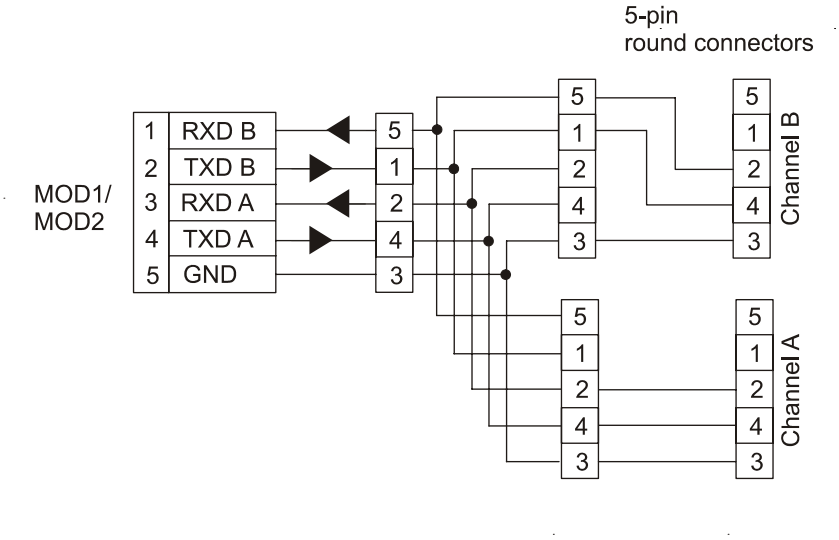


Figure 154 Suggested T-connection in Dual Port Mode

DSI485A

The DSI485A communication module can be configured either for a 2-wire line or for a 4-wire line when the receive and transmit lines are separated. If the module is configured for a 2-wire line, the transmitter is enabled only during the transmission. Normally, the 2-wire

connection is used to connect several devices to the same communication line. The 4-wire mode is the default mode.

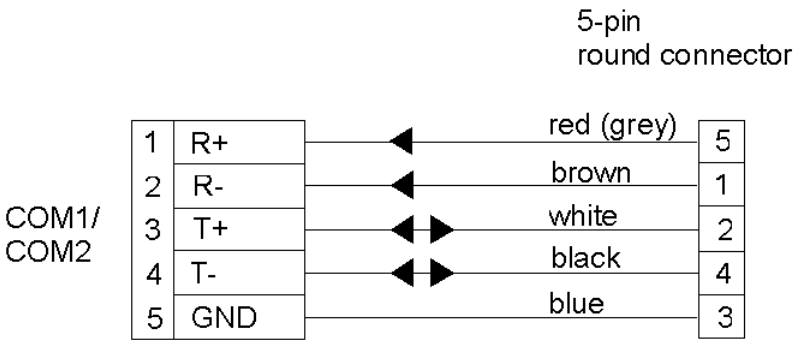


Figure 155 DSI485A Wiring Diagram

NOTE	In 2-wire mode, only T+ and T- pins are used.

DSI486

Channel A is always used in the RS-485 mode. In 2-wire RS-485, both transmitted and received data is sent via this channel. In 4-wire RS-485 this channel can either transmit or receive depending on the configuration. Jumper X4 defines the line terminating resistor for the data channel A. Remove the jumper X4 if you do not need the terminating resistor of DSI486. Figure 156 on page 214 provides a schematic wiring diagram for dual RS-485.

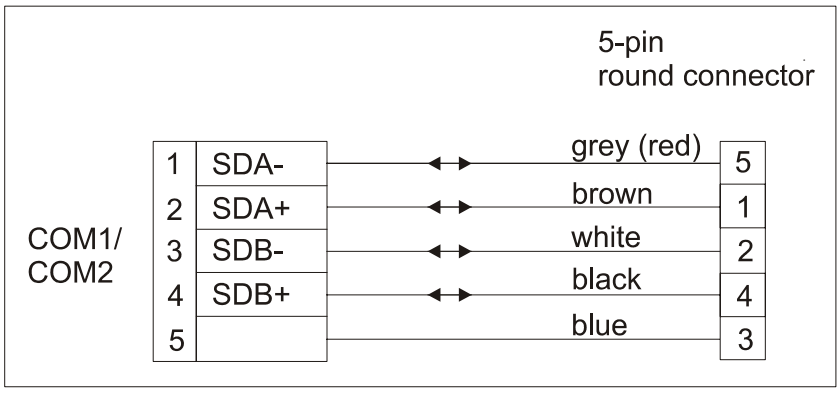


Figure 156 DSI486 Wiring Diagram for Dual RS-485

Channel B can be used either in the RS-485 mode or in the RS-232 mode. In 2-wire RS-485, both transmitted and received data is sent via this channel. In 4-wire RS-485, this channel can either transmit or receive depending on the configuration.

Figure 156 on page 214 provides a schematic wiring diagram for the dual RS-485 connection, the dual 2-wire connection utilizing both channels. The correct jumper settings for the channel B are listed in Table 38 on page 215. The jumpers are located on the module as illustrated in Figure 157 on page 215.

Table 38 The Jumper Settings for Channel B in the RS-485 Mode

Jumper	Connected Pins	Function
X3	1-2	Sets the RS-485 mode active for the channel B.
	3-4	
X6	1-2	
X5	1-2	The line terminating resistor is in use with RS-485.

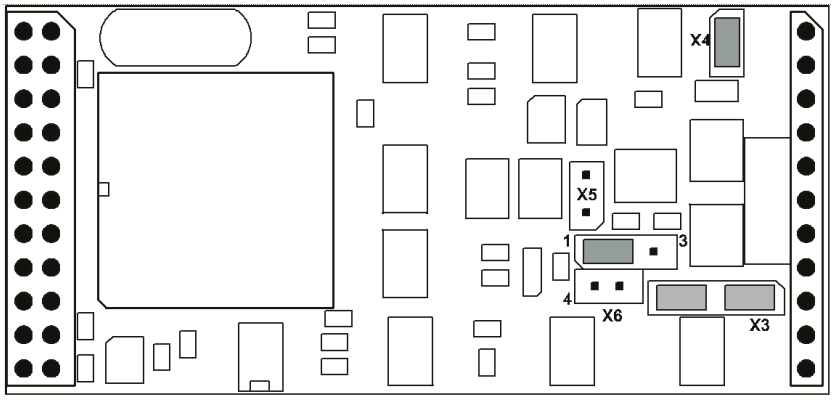


Figure 157 DSI486 Default Jumper Locations

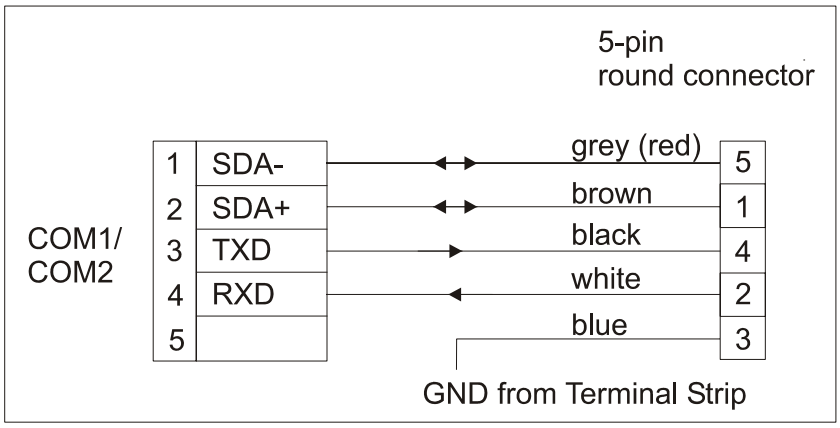


Figure 158 DSI486 Wiring Diagram for RS-485 and RS-232

Figure 158 on page 216 provides a schematic wiring diagram for the combination of the RS-485 and RS-232 connection. The correct jumper settings for the channel B are listed in Table 39 on page 216.

Table 39 The Jumper Settings for Channel B in the RS-232 Mode

Jumper	Connected Pins	Function
X3	2-3	Sets the RS-232 mode active for the channel B.
X6	1-4	
	2-5	
X5	None	The line terminating resistor is not in use at all.

The DSI486 module also provides an SDI-12 connection. The SDI-12 line uses one wire for data and is limited to a maximum length of 60 meters. Figure 159 on page 217 provides a schematic wiring diagram for the SDI-12 connection and the 12 VDC power supply for a sensor. The jumper settings should be as shown in Figure 157 on page 215.

Simultaneously with the SDI-12, you can connect channels A and B in the 2-wire RS-485 mode. If you take all three channels in use, you either need three free connectors in the flange or an optional junction box.

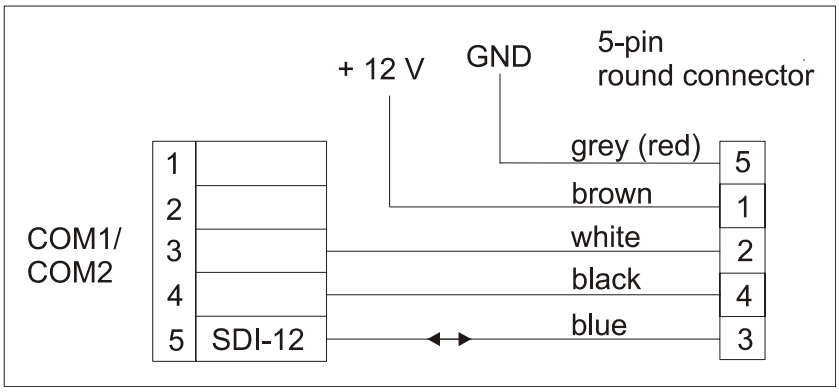


Figure 159 DSI486 Wiring Diagram for SDI-12 and 12 VDC Power Supply

DMX501

The DMX501 modem module can be configured for a point-to-point line or for a multidrop modem network. If a modem is configured for multidrop use, the outgoing carrier is valid only during transmission. If MAWS is the master in the multidrop network, DMX501 can be normally configured for point-to-point use.

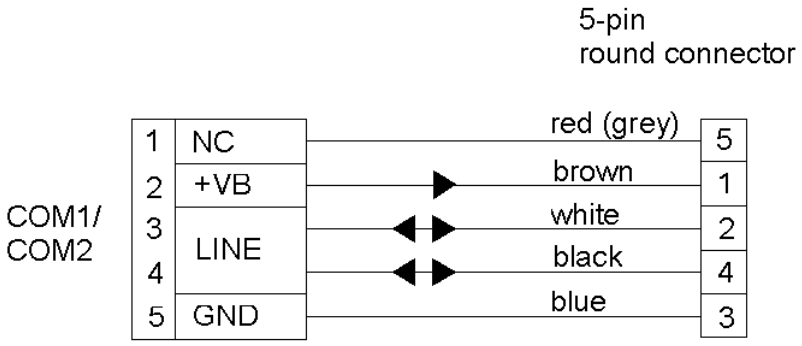


Figure 160 DMX501 Wiring Diagram

UHF Radio Modem

When using UHF Radio Modem SATELLINE 3AS, the DSU232 Communication Module should be used to provide an additional RS-232 output for the radio modem, leaving the standard COM port (**COM0**) free for maintenance purposes.

For powering of the radio modem, you need a mains (AC) power supply or a mains/solar power supply with the backup batteries. The standard solar panel can not supply sufficient power for the radio modem. In addition, you have to change the wiring to be able to use the **MOD1** port and the provided cable for powering the radio modem from the **External DC (+ExtDC)** of the logger.

Follow the procedure below to wire the radio modem SATELLINE 3AS with MAWS:

1. Remove the logger's cover and install the DSU232 communication module to the MOD1 location.
2. Reassemble the logger's cover.
3. Disconnect the wires **Red** and **Brown** from the **MOD1** connector (number 2 in Figure 161 on page 218). Connect the **Red** wire to **GND** and the **Brown** wire to **+ExtDC** terminal of the **Power** connector (1).

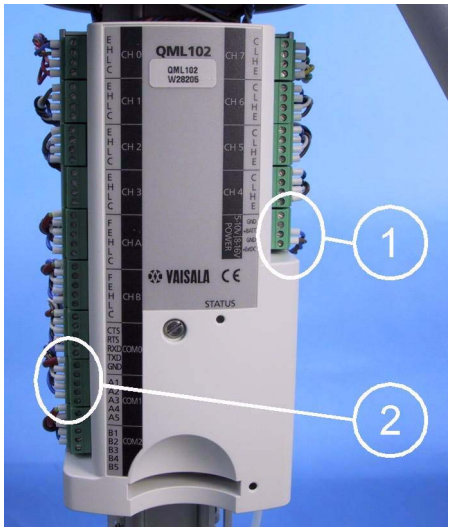


Figure 161 Wire Modifications with Radio Modem

4. Connect the ready-made radio modem's cable to the port **MOD1** in the lower base of the tube.

NOTE	It is recommended to label these modifications so that no other equipment is connected to **MOD1** by mistake. The 12 VDC voltage may damage some equipment.

5. Configure the radio modem with MAWS Lizard. Refer to Configuring Modem Options Technical Reference for instructions.

Connector Adapters

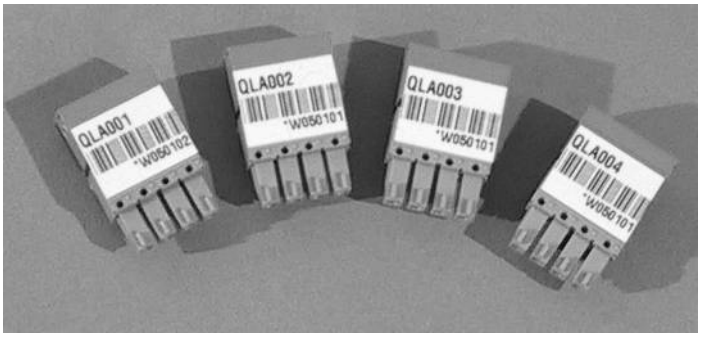


Figure 162 Connector Adapters

With some sensors, you have to install a connector adapter between the connector on the logger and the cable connector. The sensor-specific connector adapters are listed in Table 40 on page 219.

Table 40 Sensor Specific Connector Adapters

Connector Adapter	Sensor(s)
QLA001	QLW101 Leaf Wetness Sensor
QLA002	DRD11A Rain Indication Sensor
QLA003	DSU12 Sunshine Duration Sensor
QLA004	DCU7110 Ultrasonic Water Level Sensor
	DCU7210 Ultrasonic Snow Level Sensor
QLA005	QFM101 Fuel Moisture Sensor
QLA008	ECH2O-M3 Soil Moisture Sensor

Soil Moisture Sensor

Soil moisture sensor uses one analog channel of the logger. You should connect the cutted sensor cable to the appropriate channel.

1. Pull the sensor cable close to the logger enclosure. Cut the cable to a proper length. Thread the cable through the connector parts in the indicated order 1-2-3-4. See Figure 163 on page 220.

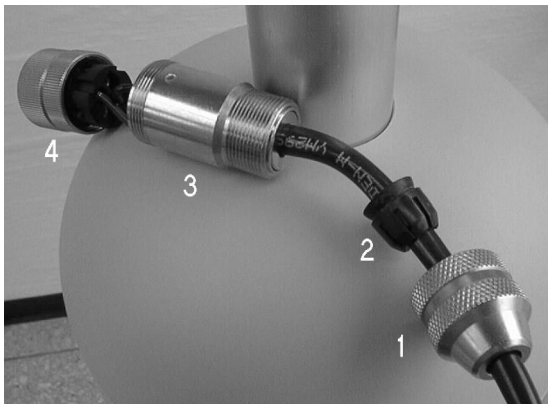


Figure 163 Assembling the Connector

2. Strip the sensor cable wires and connect them to connector terminals according to Table 41 on page 220. Make sure that the spring of the lead-in connector is in good contact with the shield. Assemble the connector and connect it to the appropriate connector of the logger enclosure.

Table 41 Cable Pins of Soil Moisture Sensor ML2x

Pin Number	Wire Color	Signal
1	Red	Supply, +
2	Yellow	Signal HI
3	Blue	Supply, -
4	Green	Signal LO

Fuel Moisture/Fuel Temperature Sensor

Fuel Moisture/Fuel Temperature Sensor uses two analog channels of the logger: one for temperature measurement and the other for moisture measurement. Moisture is measured via one of the channels CH1 to CH3. You should connect the sensor cable to the appropriate channel. Temperature is measured with one of the channels CH4 to CH7 and therefore you should modify the wiring as instructed below:

1. Loosen and remove two hand screws beneath the tube. Slide the tube down to expose the logger.
2. Select one of the analog channels, CH1 ... CH3, and place the connector to the selected input channel at the logger. The exact channel depends on your configuration.
3. Remove the connector from the selected temperature measurement channel, that is, one of the channels CH4 ... CH7. The removed cables and their connector are not needed. Insert adapter QLA005 to the channel and place the connector on top of it.

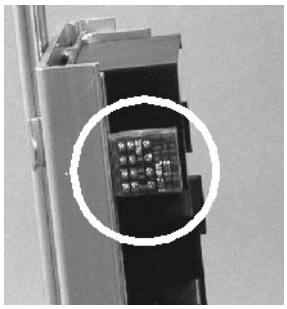


Figure 164 Adapter Installed to Connector

4. Modify the wiring according to Table 42 on page 222.

Table 42 Modified Wiring with QFM101

Wire Color	Standard Connection Pin at the Logger	Modified Connection Pin at the Logger
Red	Not connected.	Connect the wire to the terminal C of the selected temperature measurement channel (CH4 ... CH7).
Brown	E	Leave as is. This wire is used for the moisture measurement.
White	H	Leave as is. This wire is used for the moisture measurement.
Black	L	Move the wire to the terminal E of the selected temperature channel (CH4 ... CH7).
Blue	C	Leave as is. This wire is used for the moisture measurement.

5. Connect the signal cable to the modified connector.

Charging of Internal Battery

The data logger has an internal battery charger circuitry that has a programmable charging voltage of 4.5 to 9.9 V and four selectable current limits: 100 mA, 300 mA, 500 mA, and 700 mA. The MAWS charger is capable of handling 6 V lead batteries from 1.2 Ah up to 2.6 Ah.

Charging voltage and charger input voltage (+ExtDC) can be measured with 1 % accuracy and charging current can be measured with 5 % accuracy. The charger is protected against reverse input voltage and temperature. In addition, it has internal reverse current blocking to facilitate using solar cells without a blocking diode.

Power Supply and Battery Types

Battery Sensing

When the logger first starts or resets, it tries to sense the battery type that is connected to its internal battery connector (4-pin header connector at PCB near POWER connector). This connector has two sense pins that

are used by charger software to automatically detect the type of the connected battery.

External Power Supply

The external DC supply is always connected to POWER connector pins +ExtDC and GND. The external power supply can be either regulated or unregulated DC supply (8 ... 30 V) or a solar cell if internal battery is present. To avoid excessive heating, 8 ... 16 V is recommended.

The required current capability depends considerably on the MAWS configuration. If there are no optional sensors or other add-ons (radios, modems, etc.) that require constant powering and measurement intervals are long (1 minute or more for humidity, temperature, and pressure), even a few dozen milliamperes are enough to keep the system alive and slowly charge the battery. If there is no internal battery, then at least a 200 mA capability is recommended to avoid resetting due to possible current peaks. If the quickest possible battery charging is required, then a 1A power supply is recommended.

NOTE The condition when external DC supply is used without an internal battery is automatically detected. In this case, the charger sets its output voltage to 9.9 V to enable maximum efficiency and minimum current consumption from supplies of 12 VDC or higher.

Solar Cell

When the solar cell is used as an external power supply, a few things should be kept in mind:

- Always use solar cell in combination with lead battery.
- To achieve the highest possible efficiency, a 6 to 8 V solar cell is recommended.

NOTE You can use a 12 V solar cell. However, half of the delivered energy is lost as heat in the linear charger regulator.

Lead Batteries

The charger is capable of charging from 1.2 to 2.6 Ah, 6 V lead acid batteries. There is room for one 1.2 Ah or 1.3 Ah battery in the logger battery compartment, and with QMB102 you can add another 1.2/ 1.3 Ah battery. If larger capacity is required, additional batteries must be connected to the POWER connector terminals GND and +BATT. Internal and external batteries can be present at the same time; they are essentially paralleled. For protection, an automatic self-recovering fuse is used.

CAUTION The battery protection fuse may trip if internal and external batteries have very different charge states when connecting them. This is due to current flowing from one battery to the other. This condition ceases when the battery voltages reach a balance after one or several trip-recover cycles.

To be able to charge the lead battery efficiently, the charger must know the total capacity of the connected lead batteries. This capacity setting is done with the following command:

battery [*capacity*]

Where capacity is the battery capacity in Ah. This value is also saved as a static parameter and is not lost if the logger is reset or unpowered.

CAUTION If too large of a capacity value is used, the battery may be permanently damaged due to excessive charge current.

Primary Cells

Primary (non-rechargeable) cells from 6 to 9 V are most suitable for use with the logger. The standard battery alternative for MAWS is a dual cell lithium battery that has a nominal voltage of 7.2 V, a 35 Ah capacity and a very wide temperature range. Common alkaline cells (4 to 6 cells in series) in a suitable battery holder can be used as well.

These batteries do not generally fit into the internal battery compartment. Therefore they have to be connected to the POWER connector terminals GND and +BATT.

NOTE Short pins 3 and 4 in the internal battery connector with jumper or preferably use a special pin header for correct battery type sensing.

If the primary cell setting is detected, the charger circuitry of the logger is completely shut off to protect the battery from reverse currents.

CAUTION Never connect voltages higher than 10 V between the terminals **+BATT** and **GND** as this may damage the logger electronics.

Lead Battery Charger Operation

The charger has three operating modes when a lead battery is detected: Normal Charge, Quick Charge and Float Charge. When the logger starts, it first checks the battery type, and if lead is found, the charging task starts and is performed once a minute.

NOTE If the internal temperature of the logger is below -20 °C (-4 °F), the charging current is limited to 100 mA regardless of the battery capacity.

Normal Charging

At first, the charging task always enters Normal Charging mode. In Normal Charge, charging voltage is set to 6.85 V corrected with temperature coefficient. Charging current is set to 300 mA, 500 mA, or 700 mA depending on the battery capacity.

If the battery is accepting certain amount of charging current and there is enough energy available at +ExtDC input, the charging task enters Quick Charge mode. In the opposite case, when the charging current drops below 0.0075 CA, even if more energy would be available, the charging task enters Float Charge mode.

If the battery is discharging (charging current is negative), the charging task always enters Normal Charge mode.

NOTE After powering up or reset, it takes several minutes to calculate the remaining capacity of the battery if the charger remains in Normal Charge mode.

Quick Charging

The purpose of the Quick Charge mode is to fill the battery as quickly as possible using a specified quick charge voltage for lead batteries. In Quick Charge, the charging voltage is set to 7.35 V corrected with temperature coefficient. Charging current is typically the same or one step higher as in Normal Charge mode.

NOTE Quick charging is not fully possible for batteries having more than 6 Ah capacity, due to the limited maximum current of the logger's charger.

When the charging current drops below 0.075 A, the charger task enters Normal Charge mode. It also sets the remaining capacity to 90 % if current dropping was caused by battery filling up rather than missing energy at +ExtDC terminal.

During Quick Charge, the remaining capacity can be reliably estimated only after a certain amount of time. This is when the charging voltage has reached the limit and the current has started to decrease. At this point, the remaining capacity is roughly 60 %. Normally, this point should be reached within two hours if the battery was completely empty.

NOTE If an empty battery (with a voltage less than 5.5 V initially) starts charging and reaches the 60 % limit very quickly (or does not even Quick Charge), it is probably damaged and should be replaced to ensure reliable operation.

Float Charging

When the charger task enters the Float Charge mode, the battery is considered to be full and the remaining capacity is set to 100 %. Charging voltage is set to 6.85 V corrected with temperature coefficient. Current limit is always 100 mA in Float Charge.

If the battery starts to discharge, the charger task enters the Normal Charge mode.

Temperature Protection

The charger protects lead batteries from extreme temperatures by limiting the charge current or shutting the charger completely off under certain conditions. This helps to prolong expected battery life.

If the internal temperature of the logger rises higher than +50 °C (122 °F), the charger shuts completely off and battery status shows "CHARGE_OFF".

NOTE	Battery manufacturers strictly forbid charging of their lead batteries above +50 °C (122 °F).

When the internal temperature of the logger drops below -20 °C (-4 °F), the charging current is limited to 100 mA to avoid unnecessary gas generation. Lead type batteries do not accept charging energy well at low temperatures. They loose the excess energy by generating gas. This may shorten the battery life. Normally, the 100 mA limit should not cause any problems, as the average current consumption of the logger is much lower.

Specifications

AWS Logger QML201

Table 43 AWS Logger QML201 General Specifications

Property	Description/Value
Processor	33 MHz, 32 bit Motorola
Memory	1MB RAM and 2 MB program
A/D conversion	16 bit
Data logging memory	1.6 MB internal Flash memory
	Up to 2 GB on optional Compact Flash memory card
Sensor inputs	10 Analog inputs (20 single ended inputs)
	2 counter / frequency inputs
	Internal channel for PMT16A pressure transducer
Serial communication	
standard	One RS-232 and one RS-485 (two wire)
optional	Two optional plug-in slots for communication modules to increase the number of the serial I/O channels up to 6 pcs
	Fast serial expansion bus for connecting, e.g., QMI108 and QMD210
speed	300 ... 38400 bps
parameters	Configurable speed, start bits, data bits, stop bits, parity, XON/XOFF, and check sum
Voltage (external powering)	8 ... 16 VDC recommended (30 V max.)
Internal battery QMB101	1.2 Ah / 6 V
Power consumption	< 10 mA / 6 V (typically with basic 5 sensors)
Temperature (operating)	-40 ... +60 °C (-40 ... 140 °F)
Temperature (storage)	-50 ... +70 °C (-58 ... 158 °F)
Humidity	0 ... 100 % RH

Table 44 AWS Logger QML201 Accuracy Specifications

Property	Description/Value
Typical accuracy across temperature range -50 ... +80 °C	Better than ± 0.06 °C
Maximum error across temperature range -35 ... +50 °C	Less than ± 0.12 °C
Maximum error at 0 °C	Less than ± 0.06 °C
Voltage measurement ±2.5 V range ±250 mV range ±25 mV range ±6.5 mV range	 Better than 0.04% of reading ± 150 μV Better than 0.06% of reading ± 20 μV Better than 0.06% of reading ± 6 μV Better than 0.12% of reading ± 6 μV
Frequency measurements	±0.003 % + resolution up to 8 kHz
Common mode range	+5 V / -4 V
Real-time-clock (standard) accuracy back-up time	 Better than 20 s/month 5 years minimum with CR1220 Lithium cell

Table 45 AWS Logger QML201 Regulatory Compliances

Property	Description/Value
Emissions	CISPR 22 class B (EN55022)
ESD immunity	IEC 61000-4-2
RF field immunity	IEC 61000-4-3
EFT immunity	IEC 61000-4-4
Surge (lightning pulse)	IEC 61000-4-5
Conducted RF immunity	IEC 61000-4-6

Internal Battery

Table 46 Internal Battery Specifications

Property	Description/Value
Type	Sealed. Lead-acid
Nominal voltage	6 V
Nominal capacity	1.2 or 1.3 Ah
Self discharge	< 3% / month
Expected lifetime	4 ... 6 years, temp. dependent
Dimensions l × w × d	97 × 54.5 × 25 mm (3.8 × 2.1 × 1 in.)
Installation	DIN-rail
Weight	0.4 kg (0.9 lb.)

Power Supplies

Table 47 Mains Power Supply QMP213 Specifications

Property	Description/Value
Mains power input range	90 ... 264 VAC, 0.25 A max., 50 ... 60 Hz
Input fuses	2 × 0.315 AT replaceable glass tube fuse, 5 × 20 mm
Input protection	Transient protection with 275V/55J VDR across the line
Input wiring	No mains cable included in std. delivery. Recommended wiring with a 2-wire cable (L, N) with no PE-wire; lead dimension 0.75 ... 1.5 mm^2; max. cable diameter 7 mm.
Output voltage	12 VDC ±5 %
Output current	2.5 A max.
Output protection	Short-circuit proof; transient protection with 14V/3J VDR across the o/p
Output wiring	Included is an o/p cable with black polyurethane sheath and a female 4-pole plug (12M std.).
Enclosure dimensions w × h × d	94 × 130 × 58 mm (3.7 × 5.1 × 2.3 in.)
Enclosure dimensions incl. mounting fixture w × h × d	130 × 200 × 85 mm (5.1 × 7.9 × 3.3 in.)
Enclosure material	PC reinforced w. glassfiber, color gray, environmental class, IP66
Mounting	To a Ø 60 or Ø 100 mm (2.36 or 3.94 in.) pole mast or to the tripod leg
Weight	0.5 kg (1.1 lb.)
Humidity	0 ... 100 %RH
Operating temperature	-40 ... +55 °C (-40 ... 131 F°)
Storage temperature	-50 ... +70 °C (-58 ... 158 F°)

Table 48 Mains Power Supply Unit BWT15SXZ Specifications

Property	Description/Value
Output power	30 W
Operating principle	SMPS
Input voltage range	85 … 264 VAC
Frequency range	47 … 440 Hz
Input current on full load 110 VAC 220 VAC	 0.6 A 0.4 A
Output voltage	+15 V, adjustable ± 10%
Output current	2 A
Efficiency	80 %
Noise, ripple, and spikes	±1 % + 50 mV_{p-p}, max.
Input regulation effect 85 … 264 VAC	±0.8 % max.
Load regulation effect 0 … 2 A	±0.9 % max.
Temperature coefficient	±0.03 %/°C
Output voltage rise time	200 ms max. at +25 °C
Hold-up time	20 ms min. at +25 °C
Over current protection	Fold-back, automatic recovering
Switching frequency (110V/230V)	50 kHz / 80 kHz
Electrical strength/ isolation: Input - Output Input - Chassis Output - Chassis Input - Output - Chassis resistance	 3 kV AC, 1 minute 2.5 kV AC, 1 minute 500 V AC, 1 minute 50 MΩ minimum
Leakage current	0.75 mA max.
Operating temperature range	-40 ... +60 °C (-40 ... 140 °F)
Weight (chassis included)	250 g (0.55 lb.)
Approvals	UL 1950; CSA 234 (IEC 950); VDE805; EN 60959 (IEC 950); CE - EMC 89/336 EEC - LVD 73/23 EEC

Table 49 Battery Regulator QBR101B Specifications

Property	Description/Value
Maximum input voltage (SMPS and Solar Panel inputs)	30 VDC
Maximum input current (SMPS)	6 A
Solar panel input	55 W max.
Recommended input voltage from SMPS input	16 VDC
Max. load current (backup output)	3.5 A
Recommended battery capacity range	4 … 72 Ah
Battery charge current for 4 Ah battery	0.5 A (selections 0.5 / 1.0 / 2.0 / 2.5 A)
Max. battery discharge current	3.5 A
Battery charge voltage selection (with external resistor)	13.7 V
Battery charge temp. comp. Coefficient	-20 mV/°C typ.
Load disconnection threshold voltage (with Lo Btry Switch)	10.0 V typ.
Load reconnection threshold voltage	12.0 V typ.
Btry Low signal threshold voltage	11.5 V typ.
Self consumption from battery (with LEDs disconnected)	0.2 mA max. @ +25 °C
Ground connection	Negative
Reverse voltage protection	Battery, solar panel
Dimensions w × d × h	90 × 80 × 25 mm
	(3.5 × 3.1 × 1 in.)
Weight	0.1 kg (0.2 lb.)
Housing	Anodized aluminum, gray
Wire terminals - battery and load wires - solar panel, DC input, and controls	Screw terminals, removable 2.5 mm^2 1.5 mm^2
MTBF (parts stress method, MIL.HDBK 271F ground benign Ta +25 °C)	> 150 000 hours

Solar Panel

Specifications

Table 50 Solar Panel SOLAR6 Specifications

Property	Description/Value
Peak power (Pp) @ 1 kW/m^2 @ +25 °C	6 W
Voltage @ peak power (Vpp)	8.3 V
Current @ peak power (Ipp)	0.72 A
Short-circuit current (Isc)	0.8 A
Dimensions l x w x d	346 x 268 x 5 mm (13.6 x 10.6 x 0.2 in.)
Weight, incl. mounting accessories	2.8 kg (6.2 lb.)
Output cable	0.9 m (35 in.) connector included

RS-232 Module

Specifications

Table 51 Unisolated RS-232 Communication Module DSU232 Specifications

Property	Description/Value
Channels	Two RS-232
DUART	Internal
Operating modes	Dual RS-232
	Single RS-232 mode with hardware flow control (RTS/CTS)
	Single RS-232 with power supply feed-through
Power supply feed-through	5 V ... 30 V, 1A max
Power consumption idle active	 5 mA 15 mA max
Temperature (operating)	-40 ... +60 °C (-40 ... 140 °F)
Temperature (storage)	-50 ... +70 °C (-58 ... 158 °F)
Humidity	0 ... 100 % RH

RS-485 Modules

Specifications

Table 52 Isolated Communication Module DSI485A Specifications

Property	Description/Value
Channels	One RS-485
Isolation	Galvanic
Operating modes	2-wire RS-485
	4-wire RS-485
Power consumption idle receiving transmitting	 5 mA 10 mA 20 mA
Connection distance (max.)	1500 m (4900 ft.)
Temperature (operating)	-40 ... +60 °C (-40 ... +140 °F)
Temperature (storage)	-50 ... +70 °C (-58 ... +158 °F)
Humidity	0 ... 100 % RH

Table 53 Dual-isolated Communication Module DSI486 Specifications

Property	Description/Value
Channels channel A channel B SDI	 RS-485 RS-232 or RS-485 SDI-12
Isolation	Galvanic
Operating modes	Two 2-wire RS-485 and SDI-12
	2-wire RS-485, RS-232, and SDI-12
Power consumption idle operating	 2.8 ... 4.3 mA 10.6 ... 12.4 mA
Connection distance (max.)	1500 m (4900 ft.)
Temperature (operating)	-40 ... +60 °C (-40 ... +140 °F)
Temperature (storage)	-50 ... +70 °C (-58 ... +158 °F)
Humidity	0 ... 100 % RH

Modem Module

Specifications

Table 54 DMX501 Specifications

Property	Description/Value
Modem chip	73K324L
Modem chip crystal frequency	11.0592 MHz
USART clock frequency	11.0592 MHz / 2
Register access	Operated through an 8-bit bus interface
Connection	2-wire Point-to-point line or Multidrop modem network
Modem protocols	V.21, 300 bps FSK V.23, 1200 / 75 bps FSK V.22, 1200 bps DPSK
Line interface	Matched to 600 Ω
TxControl signal	Configurable
Supply voltage	5 V (+4.75 ... +5.50 V)
Current consumption Reset / power-down Operation	 9 mA 26 mA
Transmit level	-10 dBm
Distance between modules	19 km (~12 mi.) with 26 AWG standard cable
Operating and storage temperature	-50 ... +70 °C (-58 ... 158 °F)
Humidity	0 ... 100 %RH, non condensing

UHF Radio Modem

Specifications

Table 55 Radio Modem SATELLINE 3AS Specifications

Property	Description/Value
Frequency range	380 ... 470 MHz
Channel spacing	12.5 / 25 kHz
Number of channels	160 / 80
Frequency stability	< ±1.5 kHz
Type of emission	F1D
Communication mode	Half-duplex
Carrier power	10 mW ... 1 W / 50 Ω
Carrier power stability	+2 dB / -3 dB
Adjacent channel power	acc. to EN 300 220-1 / ETS 300 113
Spurious radiations	acc. to EN 300 220-1 / ETS 300 113
Sensitivity	-116 ... -110 dBm (BER < 10 E-3)
Co-channel rejection	> -12 dB
Adjacent channel selectivity	> 60 dB /> 70 dB
Intermodulation attenuation	> 65 dB
Spurious radiations	< 2 nW
Interface	RS-232 or RS-422, RS-485
Interface connector	D 15, female
Data speed of RS interface	300 ... 38 400 bps
Data speed of radio interface	19 200 bps (25 kHz channel) 9600 bps (12,5 kHz channel)
Data formats	Asynchronous data
Operating voltage	+9 ... + 30 VDC
Power consumption	1.8 VA typical (receive) 6.0 VA typical (transmit) 0.05 VA typical (when DTR is "0")
Temperature range	-25 ... +55 °C (-13 ... +131 °F)
Antenna connector	TNC, 50 Ω, female
Construction	Aluminum enclosure
Dimensions h x w x d	137 × 67 × 29 mm (5.4 × 2.6 × 1.1 in.)
Installation plate	130 × 63 × 1 mm (5.1 × 2.5 × 5/128 in.)
Weight	250 g (0.55 lb.)

Weather Transmitter

Performance

Table 56 Barometric Pressure

Property	Description/Value
Range	600...1100 hPa
Accuracy	± 0.5 hPa at 0...30°C (+32...+86 °F)
Output resolution	± 1 hPa at -52...+60 °C (-60...+140 °F)
Units available	hPa, Pa, bar, mmHg, inHg

Table 57 Air Temperature

Property	Description/Value
Range	-52...+60 °C (-60...+140 °F)
Accuracy (for sensor element) at +20 °C (+68 °F) For accuracy over temperature range, see the following graph	± 0.3 °C
Output resolution	0.1 °C (0.1 °F)
Units available	°C, °F

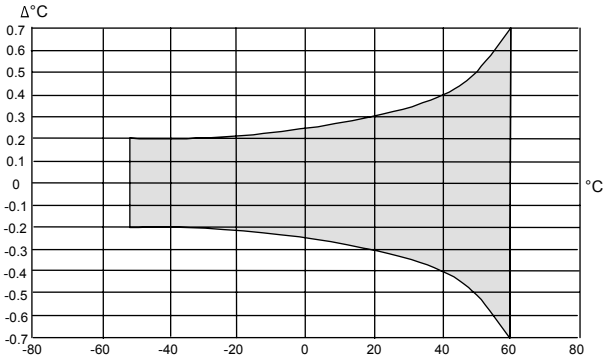


Figure 165 Accuracy Over Temperature Range

Table 58 Precipitation

Property	Description/Value
Rainfall	Cumulative accumulation after the latest auto or manual reset
Collecting area	60 cm2
Output resolution	0.01 mm (0.001 in)
Field accuracy for daily accumulation	Better than 5 %[1], weather dependent
Units available	mm, in
Rain duration	Counting each 10-second increment whenever droplet detected
Output resolution	10 s
Rain intensity	Running one minute average in 10 second steps
Range	0 ... 200 mm/h (broader range with reduced accuracy)
Units available	mm/h, in/h
Hail	Cumulative amount of hits against collecting surface
Output resolution	0.1 hits/cm2, (1 hits/in2), hits
Units available	hits/cm2, hits/in2, hits
Hail duration	Counting each 10 second increment whenever hailstone detected
Output resolution	10 s
Hail intensity	One minute running average in 10 second steps
Output resolution	0.1 hits/cm2h (1 hits/in2h)
Units available	htis/cm2h, hits/in2h, hits/h

1. Due to the nature of the phenomenon, deviations caused by spatial variations may exist in precipitation readings, especially in short time scale. The accuracy specification does not include possible wind induced error.

Table 59 Relative Humidity

Property	Description/Value
Range	0...100 %RH
Accuracy	± 3 %RH at 0 ... 90 %RH ± 5 %RH at 90 ... 100 %RH
Output resolution	0.1 %RH
PTU measuring interval	
Measuring interval	1...3600 s (=60 min), at one second steps

Table 60 Wind

Property	Description/Value
Wind speed	
Range	0...60 m/s
Response time	0.25 s
Available variables	Average, maximum, and minimum
Accuracy	± 0.3 m/s or ± 2 % whichever is greater
Output resolution	0.1 m/s (km/h, mph, knots)
Units available	m/s, km/h, mph, knots
Wind direction	
Azimuth	0...360°
Response time	250 ms
Available variables	Average, maximum, and minimum
Accuracy	± 2°
Output resolution	1°
Measurement frame	
Averaging time	1...900 s (= 15 min), at one second steps, on the basis of samples taken at 4, 2, or 1 Hz rate (configurable)
Update interval	1...3600 s (= 60 min), at one second steps

Operating Conditions

Table 61 Operating Conditions

Property	Description/Value
Temperature operation storage	 -52...+60 °C (-60...+140 °F) -60...+70 °C (-76...+158 °F)
Relative humidity	0...100 %RH
Pressure	600...1100 hPa
Wind	0...60 m/s
Electromagnetic compatibility	EN61326: 1997 + Am 1:1998 + Am2:2001 Electrical equipment for measurement, control and laboratory use - EMC requirements; Generic environment

Inputs and Outputs

Table 62 Inputs and Outputs

Property	Description/Value
Operation voltage	5[1]... 30 VDC
Average power consumption minimum maximum typical	 0.07 mA @ 12 VDC (SDI-12) 13 mA @ 30 VDC (constant measurement of all parameters) 3 mA @ 12 VDC (with default measuring intervals)
Heating voltage recommended ranges absolute max 	Options: DC, AC, full-wave rectified AC 12 VDC ± 20 %, 1.1 A max 24 VDC ± 20 %, 0.6 A max 68 Vp-p ± 20 % (AC), 0.6 Arms max 34 Vp ± 20 % (f/w rect. AC), 0.6 Arms max 30 VDC 84 Vp-p (AC) 42 Vp (f/w rect. AC)
Digital outputs	SDI-12, RS-232, RS-485, RS-422
Communication protocols	SDI-12 v1.3, ASCII automatic & polled, NMEA 0183 v3.0 with query option

1. Below 5.3 V the measurement performance for high wind speeds may be degraded.

Materials

Table 63 Materials

Property	Description/Value
Radiation shield, top, and bottom parts	Polycarbonate + 10 % glass fibre
Precipitation sensor plate	Stainless steel (AISI 316)
Weight	650 g (1.43 lbs)

General

Table 64 General

Property	Description/Value
Self-diagnostic	Separate supervisor message, unit/status fields to validate measurement stability
Start-up	Automatic, < 5 seconds from power on to the first valid output

Dimensions

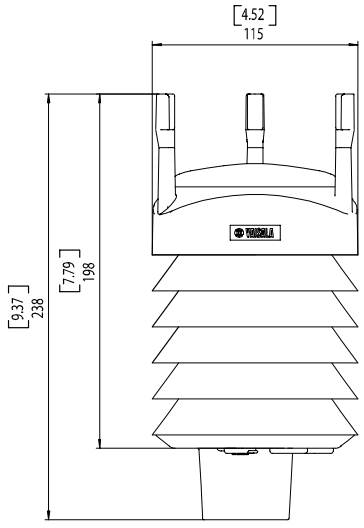


Figure 166 WXT510 Dimensions in mm [inches]

Combined Wind Sensor

Specifications

Table 65 Anemometer Specifications

Property	Description/Value
Sensor/Transducer type	Dual Reed switch
Measuring range	0.5 ... 60 m/s (1 ... 117 kt)
Starting threshold	< 0.4 m/s (0.8 kt)
Distance constant	2 m (6.6 ft)
Transducer output	1 Hz ~ 0.7 m/s
Accuracy ≤ 10 m/s > 10 m/s	 ±0.3 m/s (0.6 kt) error < 2 %
Transfer function, where U = wind speed [m/s] F = output frequency [Hz]	U = -0.24 + F × 0.699

Table 66 Vane Specifications of WMS302

Property	Description/Value
Sensor / Transducer type	Potentiometer
Measuring range	0 ... 360°
Starting threshold	< 1.0 m/s
Damping ratio	0.3
Overshoot ratio	0.4
Delay distance	0.6 m
Accuracy	Better than ±3°

Table 67 Common Specifications

Property	Description/Value
Supply voltage	3 ... 15 VDC
Electrical connections	5-pin male with 12 mm threads
Body material	AlMgSi, gray anodized
Cup material	PA, reinforced with carbon fiber; black
Vane material	PA, reinforced with glass fiber, white
Operating temperature	-40 ... +55 °C (-40 ... +131 °F)
Storage temperature	-60 ... +65 °C (-76 ... +149 °F)
Dimensions h × w	265 × 360 mm (10.4 × 14.2 in.)
Weight	360 g (12.7 oz)

Table 67 Common Specifications (Continued)

Property	Description/Value
MTBF	The calculated mean time between failure is 4.4×10^5 h for permanent installations. The value equals to 2.27 when expressed in a failure frequency during 10^6 hours of use.
MTTR	Mean time to repair is 0.2 h.

Dimensions

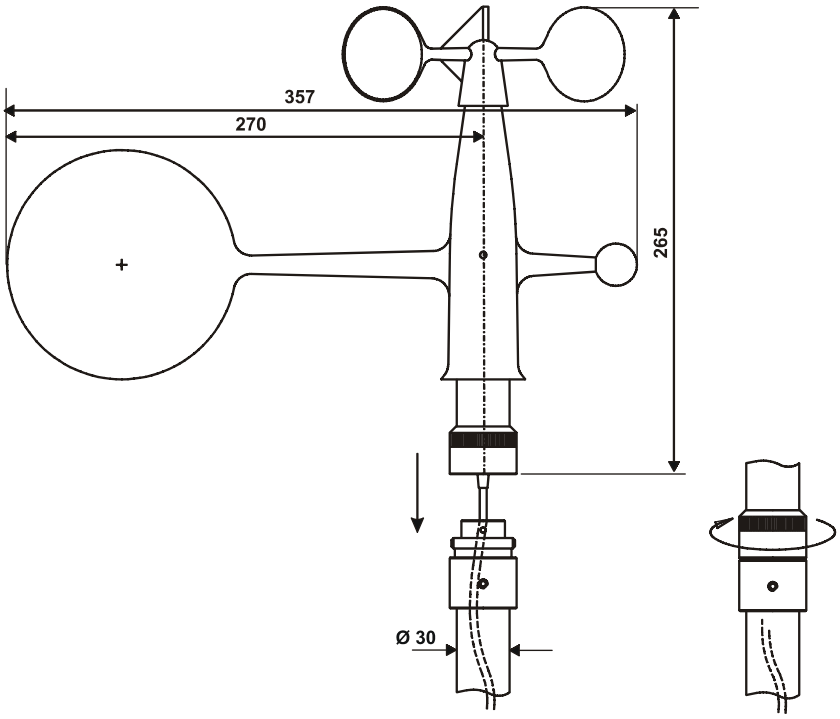


Figure 167 Dimensions (in mm) of the Combined Wind Sensor

Air Temperature and Relative Humidity Sensor

Specifications

Table 68 Air Temperature and Relative Humidity Sensor's General Specifications

Property	Description/Value
Operating temperature range	-40 ... +60 °C (-40 ... +140 °F)
Storage temperature range	-40 ... +80 °C (-40 ... +176 °F)
Supply voltage	7 ... 35 VDC
Settling time	500 ms
Power consumption	< 4 mA
Output load	>10 kΩ (to ground)
Weight (including package)	350 g (0.77 lb.)
Housing material	ABS plastic
Housing classification (electronics)	IP 65 (NEMA 4)
Sensor protection (standard)	Membrane filter, part no. 2787HM
Dimensions in mm (inches)	See Figure 168 on page 245
Emissions	Radiated interference, test setup according to EN55022
Radiated interference (IEC 1000-4-3) immunity	Level 3 (10 V/m)
Electrostatic discharge (IEC 801-4) immunity	Level 4

Table 69 Air Temperature and Relative Humidity Sensor's Temperature Specifications

Property	Description/Value
Temperature sensor	Pt-100 IEC 751 1/3 Class B
Accuracy	< ±0.2 °C (± 0.36 °F)
Output signal	Resistive four-wire connection

Table 70 Air Temperature and Relative Humidity Sensor's Humidity Specifications

Property	Description/Value
Humidity sensor	HUMICAP®180
Measurement range	0.8 ... 100 %
Output scale	0 ... 100 %RH equals to 0 ... 1 VDC
Accuracy at +20 °C (+68 °F) including non-linearity and hysteresis	±1 % against factory references
	±2 % (0 ... 90 %RH)
	±3 % (90 ... 100 %RH)
Typical long-term stability	Better than 1 %RH per year
Temperature dependence	±0.05 %RH/°C
RH response time (90 %) at +20 °C	15 s with membrane filter

Dimensions

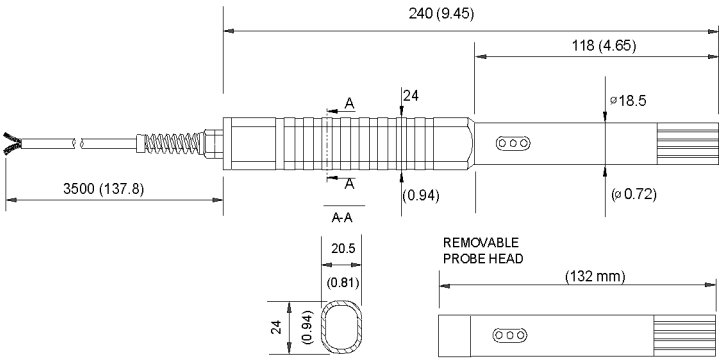


Figure 168 Sensor Dimensions in mm (inches)

Pressure Sensor

Specifications

Table 71 Pressure Sensor PMT16A Specifications

Property	Description/Value
Sensor type	Vaisala BAROCAP® (silicon capacitive)
Measuring range	600 ... 1100 hPa
Resolution	0.1 hPa
Accuracy	±0.3 hPa including one year drift (with factory calibration)
Operating temperature	-40 ... +60 °C (-40 ... 140 °F)

Rain Gauges

Specifications

Table 72 Rain Gauge QMR101 Specifications

Property	Description/Value
Sensor/Transducer type	Self-emptying tipping spoon/magnet
Funnel diameter	159.6 mm (6.28 in.)
Orifice (opening area)	200 cm^2 (31 $in.^2$)
Sensitivity	0.2 mm (1/128 in.)
Capacity	144 mm/h (5.7 in./h)
Accuracy < 24 mm/h (<0.9 in/h) < 120 mm/h (<4.7 in/h)	 < ±5 % < ±10 %
Material	UV stabilized plastic
Cable	Included
Weight	380 g (0.84 lb.)

Table 73 Rain Gauge QMR102 Specifications

Property	Description/Value
Sensor/transducer type	Tipping bucket/reed switch
Funnel diameter	254 mm (10 in.)
Orifice (opening area)	500 cm^2 (77.5 $in.^2$)
Sensitivity	0.2 mm (1/128 in.)
Capacity	120 mm/h (4.7 in./h)
Accuracy < 24 mm/h < 120 mm/h	 < ± 1 % (weather dependent) < ± 5 %
Material	UV stabilized plastic
Cable	6 m (19.7 ft.)
Weight (w/o installation plate)	1000 g (2.2 lb.)

Pyranometers

Specifications

Table 74 Global Solar Radiation Sensor QMS101 Specifications

Property	Description/Value
Sensitivity	100 μV/W/m^2 (nominal)
Spectral response	Equals silicon
Operating temperature	-30 ... +70 °C (-22 ... 158 °F)
Response time	< 1 second
Range	2000 W/m^2
Temperature dependence	+0.15 %/°C
Directional error	< 10 %
Spectral range	0.4 ... 1.1 micron
Cable length	3 m (9.8 ft.)

Table 75 Global Solar Radiation Sensor QMS102 Specifications

Property	Description/Value
Maximum irradiance	2000 W/m^2
Spectral range	305 ... 2800 nm (50% points)
Sensitivity	10 ... 35 $\mu V/W/m^2$
Impedance	79 ... 200 Ω
Response time	18 seconds (95 %)
Non-linearity	± 2.5 % (< 1000 W/m^2)
Temperature dependence of sensitivity	6 % (-10 ... +40 °C, -14 ... 104 °F)
Operating temperature	-40 ... +80 °C (-40 ... 176 °F)
Zero-offset due to temperature changes	< 4 W/m^2 @ 5 K/h temp. change
Tilt response	< ±2 %
Signal output (atmospheric condition)	0 ... 50 mV
Field of view	180°
ISO class	Second class
Cable length	10 m (33 ft.)

Net Solar Radiation Sensor

Specifications

Table 76 Net Radiation Sensor Specifications

Property	Description/Value
Spectral response	0 ... 100 μm
Detector protection	Teflon coated (no domes)
Sensitivity (upper detector)	10 μV/W/m^2 (nominal)
Recommended output range	-25 ... +25 mV
Sensor asymmetry	20 %
Range	-2000 ... +2000 W/m^2
Response time (1/e)	20 s (nominal)
Directional error	< 30 W/m^2 (0 ... 60° @ 1000 W/m^2)
Stability	< ±2 % per year
Non-linearity	< 1 % up to 2000 W/m^2
Operating temperature	-30 ... +70 °C (-22 ... 158 °F)

Soil/Water Temperature Sensors

Specifications

Table 77 Soil/Water Temperature Sensor QMT103 Specifications

Property	Description/Value
Sensor Type	Pt-100 type RTD element
Performance (accuracy)	Better than +0.08 °C at 0 °C, conforms to 1/4 DIN 43760B
Sensitivity	0.385 Ω/°C (DIN 43760)
Measurement range	- 50 ... +60 °C (-58 ... +140 °F)
Dimensions l × Ø	100 × 7.5 mm (3.9 × 0.3 in.)
Material	Stainless steel, AISI 316
Watertight	0.1 ... 4 bar
Cable Extension	PUR black, 5 × 0.5 mm^2 Cu, 5 m (16.4 ft.) 10 meter (32.8 ft.)shielded cable with male-female connectors
Ingress protection	IP68 (connector)

Table 78 Soil Temperature Sensor QMT107 Specifications

Property	Description/Value
Measurement range	-40 ... +60 °C (-40 ... +140 °F)
Output signal	Four-wire connection
Temperature sensor	7 × Pt-100 IEC 751 1/3 Class B
Temperature reference	100R00 0.01% 5 ppm resistor
Accuracy, when zero-point calibration has been activated	±0.3 °C
Operating temperature range	-40 ... +60 °C (-40 ... +140 °F)
Storage temperature range	-40 ... +80 °C (-40 ... +176 °F)
Supply voltage VCC	6 ... 30 VDC
Settling time	<10 ms
Power consumption	<1.5 mA
Output load	>1 MΩ (to ground)
Weight (gross/net)	875/640 g (1.93/1.41 lb.)
Cable length	1 m (3.3 ft.)
Housing material	Glass fiber tube/epoxy fill
Housing classification (electronics)	IP 68 (NEMA 4)
Dimensions l × Ø	1200 × 20 mm (47.2 × 0.8 in.)

Emissions

Radiated interference test setup is according to EN55022.

Immunity

Table 79 Immunity Tests

Test	Test Setup	Performance Criteria
Static discharge ESD	IEC 1000-4-2	B
Radiated interference	IEC 1000-4-3 (3 V/m)	B
Fast transient EFT	IEC 1000-4-4	B
Conducted interference	IEC 1000-4-6	B

Block Diagram

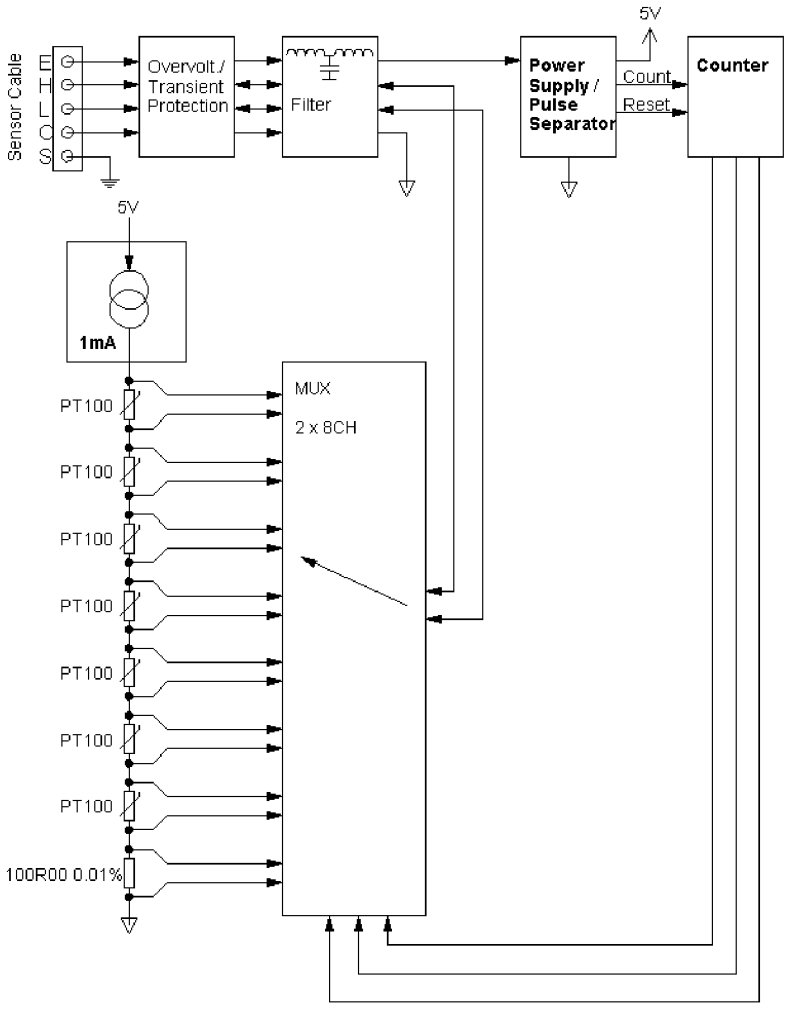


Figure 169 Soil Temperature Sensor QMT107 Block Diagram

Soil Moisture Sensor

Specifications

Table 80 Soil Moisture Sensor ML2x Specifications

Property	Description/Value
Full Range	0 ... 1.0 $m^3.m^{-3}$
Accuracy	±0.02 $m^3.m^{-3}$ after calibration to a specific soil type, or, ±0.05 $m^3.m^{-3}$ using the supplied soil calibration, in all 'normal' soils, over range 0.05 to 0.6 $m^3.m^{-3}$ and 0 to 40 °C ambient temperature.
Soil conductivity range	Accuracy figures apply over a soil conductivity range of 0 to 100 $mS.m^{-1}$. Calibratable up to 2000 $mS.m^{-1}$.
Soil sampling volume	90% influence within cylinder of 2.5 cm diam., 6 cm long, (approx 30 cm^3), surrounding central rod.
Environment	Can be buried to wide ranging soil types or water for long periods without malfunction or corrosion.
Stabilization time	1 ... 5 s from power-up, depending on accuracy required.
Response time	Less than 0.5 s to 99% of change
Duty cycle	100 % (continuous operation possible)
Input requirements	5 ... 15 VDC unregulated
Current consumption	19 mA typical, 23 mA max.
Output signal	Approx. 0 ... 1 VDC for 0 ... 0.5 $m^3.m^{-3}$
Dimensions	Measuring rods 60 mm (2.4 in.), overall length 207 mm (8.1 in.) including pins (see Figure 170 on page 253).
Extension Tubes (optional)	For convenient placement and removal when burying. Choice of 0.5 m (19.7 in.) or 1 m (39.4 in.). Can be joined.
Case material	PVC
Rod material	Stainless steel
Cable length	Standard 5 m (16.4 ft.). Maximum length 100 m (328 ft.)
Weight with 5 m (16.4 ft.) cable	350 g (0.77 lb.)

Dimensions

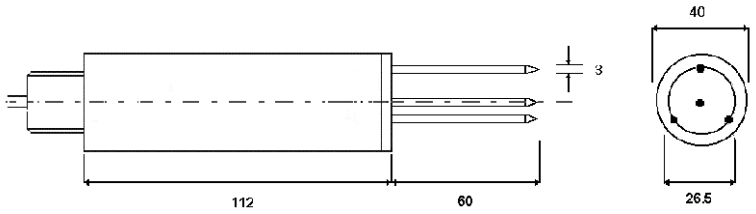


Figure 170 Soil Moisture Sensor Dimensions in mm

Soil Moisture Sensor

Specifications

Table 81 Soil Moisture Sensor ECH2O-M3 Specifications

Property	Description/Value
Measurement parameter	Volumetric soil moisture
Full range	0 ... 1.0 m^3/m^3
Accuracy	±3 % typical
	±1 % with soil specific calibration from 0 to 50 °C ambient temperature
Measurement time	10 ms
Resolution	0.002 m^3/m^3
Environment	Can be buried to wide ranging soil types for long periods without malfunction or corrosion
Stabilization time	10 ms from power-up
Current consumption	2 mA when measuring
Dimensions l × w × h	254 × 32 × 1.5 mm (10 × 1.25 × 0.06 in.)
Cable length	3.28 m (10 ft)

Submersible Water Level Sensor

Specifications

Table 82 Water Level Sensor PR-36W Specifications

Property	Description/Value
Measuring range	From 0 up to 40 m
Performance (accuracy)	0.1 % of F.S. [1] [2] [3]
Resolution	< 0.01 %. F.S.
Output signal	4 ... 20 mA, 2- wire
Operating temperature	-40 ... +90 °C
Compensated temperature range	0 ... +40 °C
Housing	Stainless steel
Weight	0.45 kg (15.9 oz.)
Vented cable	Multi-core shielded cable with venting, PE
Cable length	To be specified in the order

1. Linearity + Hysteresis + Repeatability + Temperature Coefficients + Zero + Span Tolerance
2. Accuracy and Resolution are valid for Basic Pressure Range
3. Linearity: Best Straight Line

Leaf Wetness Sensor

Specifications

Table 83 Leaf Wetness Sensor QLW101 Specifications

Property	Description/Value
Sensor type	Artificial leaf electrical resistance
Excitation	Bipolar (5V nominal) built-in
Time constant	2 seconds
Current output	Variable resistance from >1 MΩ (dry) to <130 kΩ (wet)
Supply voltage	1mA (typical) at +5 VDC ±10%
Sensor area	28 cm^2
Attached cable length	5 m (16.4 ft.)
Cable type	2-twisted pair, 24 AWG shielded cable with UV-resistant jacket, wires stripped and tinned
Recommended max. cable length [1] 24 AWG Cable (3-conductor) 22 AWG 2-Twisted Pair Cable 18 AWG Cable (3-conductor)	 91 m (299 ft.) 194 m (636 ft.) 218 m (715 ft.)
Substrate material	Glass-reinforced, ceramic-filled laminate
Grid material	1 oz. copper, nickel, and 50 μin gold plate
Mounting bracket	White powder-coated aluminum
Dimensions h × w × t	51 × 38 × 6 mm (2 × 1.5 × 0.24 in.)
Weight	227 g (0.5 lb.)

1. Increasing the cable length above the recommended maximum cable length causes measurement error in the form of lower moisture readings.

Fuel Moisture/Fuel Temperature Sensor

Specifications

Table 84 Fuel Moisture/Fuel Temperature Sensor Specifications

Property	Description/Value
Fuel moisture sensing element	Dry ponderosa pine dowel with embedded wire electrodes
Fuel moisture measurement principal	Capacitance of wood calibrated to read per cent of moisture by weight.
Fuel moisture measurement accuracy	
0 ... 12 %FM [1]	±1.9 %FM RMSE [2](two-weeks period)
12 ... 30 %FM	±3.6 %FM RMSE
>30 %FM	±16 %FM RMSE
Temperature sensor	Single thermistor
Conversion table range	-50 ... +50 °C (-58 ... +122 °F)
Temperature measurement accuracy	±0.2 °C (-20 ... +80 °C)
Size Ø × l	28.6 × 305 mm (1.13 × 12 in.)
Weight	125 g (0.28 lb.)

1. %FM = Measured fuel moisture units
2. RMSE = Root Mean Square Error

APPENDIX A
GLOSSARY

This appendix contains glossary with explanations of some general meteorological and technical terms and terms used in specifications.

Accuracy	The degree of conformity of a measured or calculated value to its actual or specified value.
Altitude	The station altitude in meters from sea level.
Atmospheric pressure	The pressure at a given point due to the gravitational force on the column of air above it. The official unit of pressure is Pascal (Pa = newton/m^2). The unit hectopascal (hPa) has been chosen to be used in meteorological barometric pressure measurement. 1 hPa = 100 Pa = 1 mbar
Barometer	Instrument for measuring atmospheric pressure.
Barometric pressure	See Atmospheric pressure.
Baud	The unit of signaling speed of a line, which is the number of transitions (voltage or frequency changes) that are made per second. The term has often been erroneously used to specify bits per second. However, only at very low speeds is baud equal to bps; for example, 300 baud is the same as 300 bps. Beyond that, one baud can be made to represent more than one bit. For example, a V.22bis modem generates 1200 bps at 600 baud.

Celsius scale	Temperature scale having the freezing point of pure water at 0 °C and the boiling point at 100 °C under standard sea level pressure. All the temperatures measured with MAWS are given in Celsius degrees.
Configuration	Set of instructions for the MAWS logger. The compiled configuration (a script) is in fact a program that runs in MAWS.
Crosswind	The wind blowing perpendicular to the course of a moving object.
Damping ratio	Describes the response of a wind vane to a sudden change in wind direction. It is defined as the ratio of the actual damping to the critical damping. Critical damping is that value of damping which gives the fastest transient response without overshoot.
Delay distance	The passage of air necessary over a wind vane to cause the vane to respond to 50 % of a step function change in wind direction.
Dew point (temperature)	The temperature at which the air, if cooled, would reach saturation, and at which dew would therefore begin to condense out on a solid surface.
Global radiation	The total of direct solar radiation and diffuse sky radiation received by a horizontal surface. Global radiation is measured by pyranometers.
Gust	The peak momentary wind velocity within a given interval of time, for example, 10 minutes.
Hexadecimal	Numbering system using the base number 16 and including the ten decimal digits (0 to 9) along with six alpha digits (A to F).
Humidity	The water vapor content of the air. Weather station sensors commonly measure relative humidity. Relative humidity is the ratio of water vapor pressure present in a gas to the maximum pressure of water vapor that could be present in the gas in that temperature.
LED	Light Emitting Diode
Logger	The processing unit of the MAWS system. The electronics of the logger take care of measuring, storing, and processing of the measured parameters.
Logging	The process of storing the measured and calculated values in the logger's memory.
Lull	The minimum of wind speed during a certain time interval.
Modem	A device that allows a terminal or computer at one location to communicate with a terminal or computer at a distant location via wire or telephone lines.

Precipitation	Term that refers to all forms of water particles that fall upon the earth. This includes rain, snow, and hail. It is the universal practice to distinguish between rain, snow, and total precipitation. Snow is sometimes measured as such and sometimes it is melted and measured as water.
Pslevel	The pressure sensor level in meters from the station altitude.
Pyranometer	An instrument that measures solar energy received from the entire hemisphere (180 degrees field of view). The output is expressed in Watts per square meter (W/m^2).
QFE	The actual atmospheric pressure at the level of station altitude or at the height of the runway threshold. The difference of the pressure sensor level and the station altitude (or runway threshold) is indicated by the pressure sensor (pslevel) setting in MAWS. QFE is normally used for aviation purposes.
QFF	The sea level pressure as QNH, but the value is corrected by the actual air temperature (or in some cases by virtual temperature, that is, temperature 12 hours ago). QFF is used in synoptical observations.
QNH (altimeter setting)	The atmospheric pressure at sea level in the standard atmosphere. The station altitude is indicated by station altitude setting in MAWS (difference of mean sea level and station altitude). QNH is used for aviation purposes.
Rain gauge	Measures precipitation based on depth, that is, the depth to which a flat surface would be covered if no water were lost by run-off or evaporation.
RS-232	Standard serial transmission protocol. A standard interface between a computer input/output port and a peripheral device.
RS-485	Standard serial transmission protocol. This protocol permits multi-drop networks (up to 32 nodes) using a single twisted pair cable.
Solar radiation	The solar energy received from the entire hemisphere. It is measured with a pyranometer.
Synchronizing time	Ties the operation to the clock for software operations. For instance, if an operation is always to be performed twenty minutes to the hour, the synchronizing time should be set to 00:40:00.
WMO	The World Meteorological Organization.
ZModem	File transfer protocol that is used when transferring files between MAWS and a terminal program.